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Zou Jiahua Calls for Construction of IC Design Center To Promote ASIC Development

92FE0541B Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 13 Apr 92 p 1

[Article by Xin Wen [6580 5113]: "State Council Vice Premier Zou Jiahua [6760 1367 5478] Points Out That We Must Take an Integrated Circuit Development Path With Chinese Characteristics, Start With the Needs of All Industries and Sectors, We Can Begin With Application-Specific Integrated Circuits"]

[Text] State Council vice premier Zou Jiahua pointed out recently that development of the electronics industry, especially development of microelectronics technology, has an extremely close relationship to national economic construction, and that the most crucial aspect is integrated circuits. We should start with the needs of all industries and sectors, and truly take an integrated circuit development path with Chinese characteristics.

Zou Jiahua discussed this issue at a report meeting concerning development of the IC industry that was held under the direction of the State Planning Commission.

Zou Jiahua said that following construction during the Sixth 5-Year Plan and Seventh 5-Year Plan, China's IC industry has a substantial foundation, but conscientious research is needed concerning how it should be further developed. Generally speaking, there are two ways to develop an IC industry. One is to develop general-purpose ICs, start with dynamic memory, and produce large amounts to form an economic scale. The other path is to develop application-specific integrated circuits [ASIC], produce them in small amounts, and have many product varieties. Actually, these two paths are not mutually exclusive, but are instead mutual complementary. ASICs and general-purpose ICs are relative and have a dialectical relationship. When a certain type of ASIC is developed to a specific degree and achieves full utilization, it can become a general-purpose IC. As user requirements change and technology advances, new ASICs can appear, continuing to develop forward in a spiraling fashion. China should certainly develop general-purpose ICs, but given China's present situation and the ability to purchase large numbers of general-purpose ICs in the international market, we can start first with ASIC. This does not mean that we will not develop conventional production lines. Instead, it concerns how things should be done to help accelerate the pace of development.

Zou Jiahua pointed out that one crucial aspect in developing ASIC is to establish several IC design centers as quickly as possible to solve the problem of product variety development. He also gave special emphasis to the need to start by solving problems in developing the IC industry and to begin with users' needs. We cannot simply pursue technical levels. He feels that technology serves applications and that developing 1 μm and sub-μm technology does not mean that 3 μm and 5 μm technology is useless. If a problem can be solved by using 3 μm and 5 μm technology, why should we use sub-μm technology? The key for televisions, for example, is increasing clarity. If this can be done using 7 or 5 circuits, why should we pursue a single circuit? Of course, we must also take into consideration the performance/price ratio for the unit as a whole. This is particularly true since under certain circumstances volume and weight play a decisive role, so we must pursue an even higher degree of integration.

Legal Protection of Chinese Integrated Circuits Intellectual Property Rights

92FE0423 Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 6 Mar 92, 9 Mar 92, 11 Mar 92

[Article in three installments by Yu Zhongyu [0205 1813 6877]]

[Part I. 6 Mar 92 p 3]

[Text] **Editor's note**: Protecting intellectual property rights involves the recognition of the creative labor of innovators and protecting their legitimate rights and interests. Protecting intellectual property rights has now become a basis for international economic and technological contacts, and it is a concrete embodiment of the Chinese government's principle of "respecting knowledge, respecting skilled personnel". The diplomatic conference convened in Washington in 1989 by the World Intellectual Property Rights Organization passed the "Treaty on Intellectual Property in Respect of Integrated Circuits" and China was among the first group of nations to sign the "Treaty". To give readers a better understanding of the issue of legislation to protect intellectual property rights for ICs, ZHONGGUO DIANZI BAO has invited senior engineer Yu Zhongyu of the Ministry of Machine-Building and Electronics Industry to write the article "Legal Protection for China's Integrated Circuits Intellectual Property Rights" (because of the substantial length of the entire article, it is being published in three parts) for the benefit of readers. Moreover, ZHONGGUO DIANZI BAO will soon publish a group of articles introducing intellectual property rights that were written by Chinese People's University Law Department professor Guo Shoukang [6753 1108 1660] and others that will describe the history and present situation of intellectual property rights, the Computer Software Protection Law, and other areas. When publication of the current article is completed, ZHONGGUO DIANZI BAO will hold "Intellectual Property Rights Knowledge Prize Competition" activities. We hope that all readers will read and collect these articles.

Integrated circuit [IC] technology is one of the most rapidly developing and most vigorous emerging technologies in the world today. Because of its profound impact on the development of a nation's economy, ensuring

national security, improving people's living standards, and many other areas, it has become an important technology with a strategic status in the world today. For this reason, the governments of all nations are paying a high degree of attention to developing IC technology. The relevant industrial circles in all countries have undertaken intense competition in technology and markets surrounding IC products. This competition became even more intense in the late 1980's. To encourage innovations in IC technology, promote development of the IC industry, and ensure that competition is carried out within a fair and reasonable scope, the establishment of a system of legal protections for IC intellectual property rights is obviously extremely necessary.

Overall, traditional intellectual property rights law can be divided into copyright law, patent law, trademark law, laws to prevent improper competition, and other types. In practice, existing laws have already been used to provide a specific degree of protection for IC intellectual property rights. However, because ICs are an emerging technology, the characteristics they express are different from the objects protected by traditional intellectual property rights law. To pursue direct and effective protection of IC products, several countries have formulated special laws and regulations to protect intellectual property rights for ICs. They do not fall under patent laws nor do they fall under copyright laws. Instead, they are a new member of the system of intellectual property rights laws.

Although IC technology in China is not very developed at present, starting with our long-term interests in protecting and encouraging intellectual innovation and developing China's IC industry, it is very necessary that we formulate some special laws and regulations in China for protection of intellectual property rights over ICs similar to the Patent Law, Copyright Law, Trademark Law, and other laws and that are adapted to the development needs of China's IC industry and conform to international principles for protection of intellectual property rights.

I. Protecting Intellectual Property Rights for Integrated Circuits Is a Requirement for China's Opening Up to the Outside World and Developing Our National Economy

A. The strategic status of integrated circuit technology and industry

IC technology is the foundation and vanguard of the modern world's new S&T revolution. The birth of the world's first IC in 1958 induced a new industrial revolution. The technology has developed at an incredibly fast pace in the 30-plus year history from the invention of the IC until today. Most of the ICs in the 1960's were of a moderate and small scale, and development of large-scale ICs began in the 1970's. By the 1980's very large scale ICs [VLSICs] were flourishing. The largest scale IC at present is a 64M DRAM that integrates 140 million components on a 200 mm^2 silicon chip. It is expected that 1,000M DRAM may be successfully developed by the end of this century. They would include over 2 billion components and have a maximum line width of 0.1 μm. Moreover, there has also been flourishing expansion in the scale of IC production. The world sales volume of ICs reached $47.6 billion in 1990 with sales of 30.9 billion pieces and it is expected that the world sales volume of ICs will surpass $100 billion by 1995 with sales of about 84 billion pieces. The annual per capita consumption of ICs in the world at present is about seven or eight pieces, and will increase to 20 to 30 by the end of this century.

The invention and development of ICs led to the emergence of modern electronic information technology. In the course of development of the modern world's new technological revolution, electronic information technology based on ICs and with computers and communications as the main aspect is the most vigorous vanguard technology. It is also an entirely new force of production with enormous potential. The world's S&T and economy have already reached this era and all types of high and new technologies are continuously coming forth. At the same time, applications of electronic information technology will restore new life to traditional industry. All of these things have IC technology as one of the bases for their development.

Modern agricultural production requires accurate weather forecasts and the quality of the world's agricultural harvests require satellite observations of ecological and environmental changes. This is particularly true for the automation of agricultural production and the application of biotechnology, none of which can be separated from electronic information technology.

Traditional industry has undergone a transition from manual operations to mechanization and on to automation, which requires the use of automatic control technology, and computers and microelectronics are the foundation of automatic control technology. Manufacturing industries in all countries are now competing to develop computer-integrated manufacturing systems (CIMS), artificial intelligence technology, and so on, none of which can be detached from ICs.

National security is also closely related to the IC industry. The indicator of a country's national defense strengths in the modern world is no longer the amount of military equipment or iron and steel. It is instead electronics technology levels. This has been fully confirmed by the several regional or local wars that have occurred during the past several years. Modern warfare is in one definite sense electronic warfare. ICs have become one of the key factors in determining victory or defeat in war.

The development of IC technology has also greatly improved and enriched people's daily lives and improved the quality of people's lives. Household appliances and electronic products with a great variety of functions have flown unceasingly into homes during the

past several years and household automation is now gradually becoming a reality.

This shows that ICs have developed to become a pillar of modern society and that per capita consumption of ICs will become a yardstick used to measure the national strength or weakness of a country.

B. China's integrated circuit industry is beginning to take shape

China's IC industry got its start in the 1960's and our IC industry has now attained a preliminary scale. China successfully developed its first VLSIC in 1986, a 64k DRAM, and we developed our first 1MB Chinese character ROM using 1.5 μm technology in 1991. There are now almost 60 units in China involved in IC research, development, and production, and the industry has a total of about 40,000 people including about 5,000 technical personnel. We had developed about 2,000 varieties of IC products by the end of 1990 and yearly output of ICs was 110 million pieces. Moreover, several key enterprises like the China Huajing Electronics Group Company, Huayue Microelectronics Company, Ltd., Shanghai Beiling Microelectronics Manufacturing Company, Ltd., and others have appeared.

The development of China's economy will create ever-growing demand for ICs in China. Demand for ICs is expected to surpass 1.2 billion pieces by 1995 and exceed 2 billion pieces by the year 2000. The Chinese government is extremely concerned with developing the IC industry and has adopted measures in policies, investments, personnel training, and other areas to create the conditions for accelerated development of the industry. China now has several IC design centers that are in the process of expanding and several 10 IC design companies may be established during the next 5 years. This shows that China's IC design industry is now gradually taking shape.

C. The necessity of legislation to protect integrated circuit intellectual property rights in China

1. To help protect the legitimate rights and interests of integrated circuit creators

IC designs are the result of intellectual labor by their creators. Their initiative to develop and create can only be motivated by legally acknowledging the creative labor of inventors and protecting their legitimate rights and interests. This is precisely embodied in the Chinese government's principle of "respecting knowledge, respecting skilled personnel". In the short term, the existence of uncompensated copying of IC layout designs would appear to be beneficial to the dissemination of IC technology and products. In the long term, however, the existence of this type of phenomenon will severely harm the enthusiasm of IC enterprises for investing in R&D and will have negative effects on the establishment and perfecting of an IC design technology system. For this reason, it is extremely necessary that we create a social environment that respects the intellectual labor achievements of others and protects the legitimate rights and interests of intellectual creators. This is the primary task in legislation to protect intellectual property rights over ICs.

2. To help promote development of the integrated circuit industry

China's IC technology is still in the initial stages of development at present and we still lag substantially behind the industrially developed nations, so the development of China's IC industry will still have to study and borrow from advanced technology in foreign countries for a while. Thus, establishing a system of legal protections for IC layout designs and providing protection in accordance with law for the IC layout designs already in commercial use in foreign countries will place substantial pressure on China's development of the IC industry in the short term. However, protection of intellectual property rights is a requirement for progress in human civilization and one of the basic conditions required to develop China's IC industry. China will rely on its skilled personnel who have experience in designing ICs to work on IC design and manufacturing, try to develop new IC product varieties, and actively create IC layout designs that conform to originality requirements to satisfy demand in the domestic and international markets. Through our efforts, China's IC industry will develop in an environment of fair and intense competition.

3. To help in further opening up to the outside world

Protection of intellectual property rights has become a foundation of international economic and technological contacts. A substantial part of the present trade friction among nations arises from the question of protecting intellectual property rights, and it has affected overall economic and trade relationships among nations. Actually, the question of intellectual property rights is now no longer simply an economic or trade issue but has grown to become a political issue in international contacts. For this reason, establishing a system of protections for China's IC intellectual property rights would help promote China's foreign trade and technical exchanges. The diplomatic conference held in Washington in 1989 by the World Intellectual Property Rights Organization passed the "Treaty on Intellectual Property in Respect of Integrated Circuits" and China was among the first group of nations to sign the "Treaty". The Chinese government will continue to adhere to the fundamental principle of opening up to the outside world and will reinforce economic, technical, and cultural exchanges and cooperation with all nations of the world on the basis of equality and mutual benefit. Legislation to protect intellectual property rights for integrated circuits will create an excellent environment for stronger cooperation between China and foreign countries in this technical realm.

[Part II. 9 Mar 92 p 3]

II. The Development of Integrated Circuit Intellectual Property Rights and Their Characteristics

A. A review of the history of intellectual property rights protection for integrated circuits

Integrated circuits are a high technology, and developing a new chip often requires the investment of several million dollars. Moreover, certain companies with advanced equipment and instruments use them to dissect products, take microphotographs, etch away layers, and do microscopic analysis, rather easily duplicating chip layout designs. The cost of copying is one-tenth to one-hundredth the cost of development, and it takes much less time. The existence of this phenomenon has seriously affected developers' product sales and recovery of their R&D investments. For this reason, the formulation of laws and regulations to protect ICs and safeguard the rights and interests of developers is both reasonable and necessary.

The United States began studying the issue of protecting intellectual property rights for ICs in the late 1970's and submitted it to Congress for discussion in October 1978. It included the forms of protection to adopt, the length of protection periods, the permissible scope of reverse engineering, and so on, and these questions aroused intense debate in the United States Congress.

In November 1984 the United States Senate and House of Representatives finally reached a common understanding and passed the "Semiconductor Chip Protection Act". It was included in Chapter 9 of the Copyright Law in the United States Legal Code but it was also a relatively independent law because, besides articles concerning registration procedures, Chapters 1 to 8 in the Copyright Law were unsuitable for use in the "Semiconductor Chip Protection Act". In May 1985, Japan promulgated the "Act for the Protection of the Circuit-Layout of Semiconductor Integrated Circuits".

The European Community Council passed a decision in June 1985 that agreed to the immediate proposal to examine the "Directive on the Legal Protection of Topographies of Semiconductor Products" issued by the EC Commission and it was formally passed in December 1986. It also called upon all member nations to complete legislation in their own countries based on the content of this directive. This directive promoted legislative work by EC members to protect intellectual property rights for integrated circuits and it became the norm for legislation in each member country.

The World Intellectual Property Rights Organization (WIPO) offered a proposal regarding the conclusion of an international treaty concerning protection of intellectual property rights for ICs. At a meeting convened by the WIPO in Washington in the United States on 26 May 1989, the "Treaty on Intellectual Property in Respect of Integrated Circuits" was passed with 45 votes in favor, five abstentions, and two votes against. This treaty is now being turned over to the governments of the various countries for signing.

By the end of 1991, the countries of the world that had promulgated laws concerning protection for intellectual property rights of integrated circuits were: the United States, Japan, Sweden, England, France, Denmark, Holland, Italy, Austria, Spain, Luxembourg, Portugal, Australia, Germany, the former Soviet Union, and others. All of these countries have adopted separate legislation to protect intellectual property rights for ICs but there are differences in the laws of each country concerning descriptions of the targets of protection. The United States law is called the "Semiconductor Chip Protection Act" and the target it actually protects is "Mask Works". The names of the laws in most of the countries in the EC adopt "Topographies of Semiconductor Products". Although there are differences in the descriptions, the essence of the protections is that they deal with a series of related images of the three-dimensional model of the interrelated structure of each layer of materials that must be used during the IC development process to protect IC products. In addition, the legislation in each of the countries provides a rather concentrated reflection of the following contents:

1. The primary rights enjoyed by creators includes two aspects, which are duplication rights and commercial implementation rights.

2. The basic condition that must be satisfied for IC layout designs to receive protection is that the layout designs have originality and are not conventional designs. On this basis, most countries also stipulate registration procedures that must be followed.

3. Protection for the IC layout designs usually concern three levels, which are the circuit diagram and design itself, the IC that is manufactured using the protected circuit diagram and design, and the protected IC product. Countries make corresponding stipulations regarding the depth of protection according to their own national conditions.

4. To adapt to the characteristics for rapid upgrading in the development of IC technology, the laws of most countries contain provisions allowing reverse engineering of ICs. The goal, however, must be to develop new and original IC layout designs, not commercial implementation.

5. The laws of all countries stipulate a 10-year term of protection for IC layout designs, and it usually starts from the day they are registered or placed into commercial application.

B. The characteristics of intellectual property rights for integrated circuits

First, IC layout designs are intangible. This is a basic characteristic of IC layout designs as the objects of

intellectual property rights. IC layout designs refer to series of related images of fixed arrangements or codes. These images:

1. Reflect the three-dimensional configurational model of the layers of materials that form an IC product.

2. Each image embodies either the whole or a part of the surface model of an IC product during each phase of its manufacturing process.

This shows that layout designs are actually a graphic configuration form of the various components in ICs and this configuration is itself abstract and intangible. It has no concrete form but when it is accompanied by a specific carrier it can become felt and known by people in the form of a carrier. When the layout design exists in an IC chip, it is manifested as a specific structural shape and this structural shape is visible. The chip becomes a carrier of the layout design at this time. Similarly, a layout design on a mask board exists in a tangible form, so the layout design on the mask board exists in the form of an image and the mask board is the carrier of the layout design. If the layout design exists in a coded state on various types of magnetic media, these magnetic media are the carriers of the layout design. On different carriers, the layout design has different modes of existence.

Second, the layout design is reproducible. Reproducibility is a necessary characteristic for copyrighted objects, and the layout design exists in the form of an image on the mask board. When the entire mask board is rephotographed, the entire layout design can be duplicated. When a magnetic disk, magnetic tape, or so on is the carrier for the layout design, regular magnetic disk or magnetic tape duplication methods can be used to copy the layout design on them. When the layout design is "solidified" into an IC product, certain technical measures likewise can be used to copy the layout design, but of course this process of duplicating the layout design is somewhat more complicated. In summary, regardless of what the carrier of an IC layout design is, and regardless of the form in which the layout design exists, people can always use appropriate measures to copy the layout design.

Third, the forms in which IC layout designs are expressed are not arbitrary. An IC is an electronic product and a particular layout design corresponds to a specific electronic function. Thus, the form in which the layout design is expressed is restricted by several technical factors. The form in which a copyright object is expressed is usually not restricted, and different authors can use entirely different forms to express the same idea or concept.

The limitations of the forms in which IC layout designs can be expressed are manifested in restrictions of the shape and size of the layout design by the requirements of circuit parameters. The layout design is also restricted by technical levels. In addition, the layout design is restricted by several physical laws, the structural integrity of the semiconductor material, the distribution of impurities, and other factors. For this reason, different plants and businesses frequently adopt identical design principles or identical characteristic line widths to design ICs, and they may even use identical circuit components.

In summary, IC layout designs cannot be arbitrarily sprinkled about like literary works. They are subject to restriction by many factors. All of these things show that IC layout designs have the characteristics of industrial property rights objects.

C. Legal forms of IC layout design protection

The reason that layout designs can be the objects of intellectual property rights is that they are intangible, which is a basic attribute of objects of intellectual property rights. Layout designs also have the dual attributes of copyright and industrial property right objects, but they do not belong entirely to any category. Thus, simply adopting any existing law to protect IC layout designs will have its disadvantages.

The Patent Law is an important measure for protecting advanced technology, but it has several restrictions in regard to ICs, which are a special industrial product. According to the requirements of the Patent Law, inventors who apply for a patent must be creative, meaning significant technological advances that are not easily seen by common technical personnel in their specialization or are not the inevitable result of logical inferences from existing technology.

Simply stated, this requires the object of protection to have substantial technical difficulty or a high degree of creativity. This obviously is somewhat of a burden for ICs.

The development of IC technology is manifested primarily in the continual reduction of the width of photoengraved lines and continual improvement in the scale of circuit integration, and all these things are the result of continual improvements in technical levels. The technical levels of one generation create IC products of one generation without any fundamental improvements in IC layout designs or without generating unexpected results.

From DRAM, the degree of integration has continually increased along with improvements in technical levels. Although there may have been changes or improvements in their design programs and component circuitry at certain stages, the design ideas are identical. At the whole component level, they include a substantially large component of existing technology that makes it difficult to attain the creativity requirements of the Patent Law, which can result in several of the most advanced ICs failing to receive protection from the Patent Law.

Moreover, in the design of ICs, and especially in several larger scale circuits, the designers often adopt many

existing and mature components and circuits for combination. This is a quick and effective design method. In the Patent Law, inventions and creations composed of various combinations of existing technology are called combined inventions. Combined inventions, however, require that various technologies be supported in function and that unexpected technical results be attained. This is hard to achieve for most ICs.

Likewise, simply adopting the Copyright Law to protect ICs has many imperfections that are manifested primarily in these areas:

1. IC layout designs are works with technical content and their value is embodied primarily in their applicability. What truly requires protection is this type of technical content. This exceeds the scope of protection of the Copyright Law. The Copyright Law only protects the arrangement and structure of books, the form of written expression, and so on. It does not protect the content introduced in books. Neither does the Copyright Law protect the application functions of technology because this type of application function does not exist in common works. The industrial applicability of IC layout designs is precisely the object that is not in the traditional Copyright Law.

2. The objects protected by the Copyright Law are not required to have a high degree of creativity. The work must simply have been completed independently by the author. Regardless of its technical level and whether or not similar works have already appeared, it will be protected by the Copyright Law without exception. IC layout designs, on the other hand, have relatively powerful technical qualities and their value is determined by the technical difficulty and newness of the layout design. What the law should protect are those layout designs that involve considerable technical difficulty or creativity. If those layout designs that have already entered the public domain and are well-understood by specialized technical personnel are protected, they would be unable to play a role in spurring progress in technological development and would instead suppress further innovation by design personnel on the basis of existing technology, which is contrary to the purpose of legislative protection of ICs.

3. The inherent idea for an unprotected work in the Copyright Law is the important principle that it only protects the form of expression of a protected work, and no idea can be monopolized by using the law. The same idea can be expressed in many forms. The layout design for an IC, however, is restricted by a variety of factors and its form of expression is extremely limited, sometimes to the extent that there is only one choice for an optimum program. Thus, it obviously is inappropriate to make the layout design, which has limited forms of expression, an object for protection by the Copyright Law.

4. According to the Copyright Law, without the agreement of the holder of a copyright, no one can copy their work in any form. Thus, in the IC industry, behavior involving "reverse engineering" violates the provisions of the Copyright Law. General purpose qualities and compatibility often both exist in an industrial product and this is extremely important for both industrial development and technical progress. Thus, reverse engineering does not involve duplicating the layout designs of other people for commercial purposes. Instead, it uses dissection and analysis of the design ideas and design methods of other people's products to aid in designing products that are compatible with them or to make further improvements on the basis of others' products to manufacture more technologically advanced ICs, and this type of behavior should be considered reasonable.

Although the Copyright Law contains provisions regarding reasonable use, reasonable use is only applicable for copying one part of another's work. "Reverse engineering", however, may require duplication of the entire layout design of another person's IC. According to the Copyright Law, the right to make improvements based on the original work should belong to the author, whereas the ultimate objective in "reverse engineering" may be to make improvements in others' ICs. If this type of behavior is seen as encroachment according to the Copyright Law, this would also be extremely unfavorable for development of the IC industry. Thus, simply applying the provisions in the Copyright Law regarding duplication rights is also inappropriate. Providing special permission for "reverse engineering" under specific conditions is one type of restriction of duplication rights as well as an important way to encourage technical progress.

As a new member of intellectual property rights objects, IC layout designs have their own unique individual characteristics. We cannot simply go along with the existing Patent Law, Copyright Law, and other related laws and regulations to provide full protection for IC layout designs. Instead, we must deal with the actual circumstances and formulate a special law. This law should borrow from certain principles in the Copyright Law and absorb relevant methods from the Industrial Property Rights Law. Because what is being protected by the law has certain properties of copyright objects and is at the same time an IC layout design that has the properties of an industrial property rights object, its mode of protection cannot simply adopt the mode used in the traditional Patent Law that does not allow other people to arbitrarily manufacture, utilize, and sell without the permission of the person holding the rights. Nor is it like the Copyright Law, in which all rights are derived centered on duplication rights.

Thus, it is a new type of intellectual property rights different from the Industrial Property Rights Law and Copyright Law that occupies a status equivalent to that of the Patent Law, Trademark Law, Copyright Law, and so on.

[Part III. 11 Mar 92 p 3]

III. The Chinese Government Is Concerned With Protecting IC Intellectual Property Rights

A. Establish a comprehensive environment for protection of IC intellectual property rights

As the result of intellectual labor, ICs concentrate many aspects of protection of intellectual property rights into one thing and they touch upon all aspects of intellectual property rights. For this reason, protection of intellectual property rights for ICs concerns the entire legal system of intellectual property rights. We have also noted that traditional intellectual property rights laws are unable to provide direct and relatively perfect protection for ICs. The Chinese Government historically has been concerned with protecting intellectual property rights. Shortly after our nation was founded, the Government Administration Council issued the "Provisional Regulations for Protection of Invention Rights and Patent Rights" (issued in August 1950), and they used this as a foundation for providing invention rights or patent rights to several inventions and creations that conformed to the conditions. Since 1976, to encourage the initiative of intellectuals for engaging in invention and innovation, and to adapt to the larger environment of reform and opening up, the Chinese Government also issued the new "Invention Award Regulations", "Natural Science Award Regulations", "Scientific and Technical Progress Regulations", "Rationalization Proposals and Technical Upgrading Award Regulations", and other laws and regulations to protect inventions and creations. China began drafting a Patent Law in 1979 and promulgated it in 1984. This in conjunction with the previously announced Trademark Law formed the basic framework of China's system of industrial property rights laws. In 1985, China joined the "Paris Treaty To Protect Industrial Property Rights", which raised China's international protection of intellectual property rights to a new level. In 1987, China issued the "Technology Contract Law" that provided a basis for readjusting the relationships in the fields in which technical achievements circulated. It also promulgated the "Copyright Law" in 1990. With this, China's system of legal protections for intellectual property rights was basically established.

The speed of China's legislation in the area of intellectual property rights was seldom seen in the world. On this foundation and in accordance with China's existing intellectual property rights laws and regulations, we now have the basic conditions for protecting intellectual property rights over ICs and ICs are certainly receiving a substantial degree of protection in China now.

1. Application of the Patent Law is used to provide protection. For IC products that have applied for patents, the patented products cannot be manufactured, marketed, utilized, or imported without the agreement of those holding the patent rights.

2. Application of the Trademark Law is used to provide protection. The relevant designers or manufacturing plants and businesses can seek protection by the Trademark Law for IC layout designs or IC products merely if they have entered market circulation. Without the permission of those holding the trademark rights, willful behavior involving the use of the registered trademarks of others that are special trademark rights registered as protected trademarks by China's Trademark Law is considered encroachment and will be subjected to varying degrees of legal sanctions.

3. Application of the relevant contract laws is used to provide protection. During the IC design and manufacturing processes, signed written contracts are used to specify the relationship of rights, interests, and duties among the interested parties. This is another frequently employed method for protecting intellectual property rights over ICs. The appropriate laws are the contract laws. China promulgated the "Foreign Economic Contract Law" in 1985 and the "Technology Contract Law" in 1987. For those ICs that could not be awarded patents, the relevant interested parties can sign corresponding contracts based on these two laws and use the Contract Law to protect their ICs. The "Foreign Economic Contract Law" can be applied for the relevant contracts signed in China by legal person or natural persons in foreign countries. It should be explained that Chinese-foreign cooperation venture enterprises, Chinese-foreign joint investment enterprises, foreign investment enterprises, and other legal persons in China were established in accordance with the relevant laws in China. Thus, the "Technology Contract Law" should be applied for technology contracts they sign with units under ownership by the whole people, units under collective ownership, and so on in China.

4. Application of the "Copyright Law" is used to provide protection. The objects protected by China's "Copyright Law" are literary, scientific, and artistic works. They include written works, music, fine art, patterns, and so on. If an IC layout design satisfies the originality requirements, it can receive protection from the "Copyright Law". It cannot be duplicated by others without permission. However, because the properties of IC layout designs themselves determine that the "Copyright Law" only provides them with partial protection, the Copyright Law can provide certain protections for ICs but cannot provide full protection.

With the exception of these circumstances, the creators of ICs can also use other relevant laws to seek protection for ICs. Overall, China's present intellectual property rights system to a certain extent provides an environment of comprehensive protection for ICs. Of course, there are several problems in this protection system that require further improvement and perfection.

B. The Chinese Government has actively participated in international legislation to protect intellectual property rights for integrated circuits

Besides trying to perfect the environment within China for protection of intellectual property rights, the Chinese government has also actively participated in international activities related to protection of intellectual property rights. During the meeting of the Paris Alliance to discuss revision of the Paris Treaty, the views of the Chinese delegation played an extremely positive role. In the area of trademarks, China has participated in the "Madrid Accord on International Registration of Trademarks". The Chinese government has also recently made preparations to join the "World Copyright Convention" and "Berne Convention on Protecting Literary and Artistic Works". In the area of protecting intellectual property rights over ICs, the Chinese government has consistently adopted active participation and principles and made an extremely beneficial contribution to the conclusion of the "Treaty on Intellectual Property in Respect of Integrated Circuits" and signed the treaty as one of the first group of signatory countries.

In 1985, the World Intellectual Property Rights Organization began organizing discussions for a meeting of experts from all countries concerning the question of protecting intellectual property rights over ICs. It convened four meetings of the Experts Commission and three Experts Consulting Conferences from developing countries. In 1988, the World Intellectual Property Rights Organization also convened a special preparation meeting for conclusion of the "Treaty on Intellectual Property in Respect of Integrated Circuits" and made preparations for the convening of a formal diplomatic conference in Washington, D.C. in May of 1989. Beginning with the First Experts Commission Conference and the First Experts Consulting Conference, China sent specialists on several occasions to participate in the Experts Commission Conference and Experts Consulting Conference to participate in discussions on drafting the treaty. Finally, in the diplomatic conference to conclude the treaty to protect intellectual property rights over ICs, the Chinese government delegation offered many constructive opinions ranging from definitions to the main body of the protections and from the content of the rights and interests to restrictions regarding rights and interests that were endorsed by most countries.

C. China's basic ideas regarding legislation to protect intellectual property rights over integrated circuits

The Chinese government has made unremitting efforts to promote the establishment of an environment for international protection of ICs. The Chinese government has also consistently worked to perfect the intellectual property rights legal system in China and establish a legal system to protect intellectual property rights over ICs. Since China signed the "Treaty on Intellectual Property in Respect of Integrated Circuits" of the World Intellectual Property Rights Organization in 1989, the government has been actively involved in organizing the relevant experts and scholars to study legislation in China to protect rights over semiconductor integrated circuit layout designs. The goal in China's legislation to protect semiconductor integrated circuit layout designs is to protect the legitimate rights and interests of creators of IC layout designs and adapt to the requirements of reform and opening up to create an excellent external environment for promoting S&T progress and economic development and to spur development of the IC industry. When drafting legislation, we must give full consideration to China's national conditions as a developing country and respect the principles of international protection for intellectual property rights. This means we must protect the rights and interests of the creators of layout designs and take into consideration the rights and interests of the public and relevant users. Only in this way can we truly promote development of the IC industry and technical progress.

Article 4 of the World Intellectual Property Rights Organization "Treaty on Intellectual Property in Respect of Integrated Circuits" stipulates that "signatories to the Treaty have the freedom to use special laws regarding layout designs, laws regarding copyrights and patents for layout designs, applications of new models, exterior designs for industrial products, and improper competition, or any other laws or combinations of these laws to implement the duties in these regulations for which they are responsible". Thus, adopting special legal protections for ICs can involve the formulation of relevant provisions based on the characteristics of the objects being protected themselves to prevent a lack of coordination with the principles and modes of patent laws, copyright laws, and other existing laws with IC layout designs. In addition, considering the fact that more than 10 countries have now formulated legislation to protect IC layout designs, all of these countries have used the adoption of special laws in their legislation to protect layout designs. For this reason, China will also adopt special legislation to protect semiconductor IC layout designs.

The essential conditions of layout designs to receive legal protection should be based on truly feasible arrangements in accordance with the characteristics of ICs and use the principle of originality in the "Copyright Law" as a basis for adding specific requirements regarding the degree of creativity. Concretely speaking, this means that protected semiconductor IC layout designs must be the independent creations of the creators, meaning the result of their own intellectual labor, and that these layout designs are not common or conventional designs in the IC industry. Compared to the creativity conditions in the Patent Law, non-common or non-conventional here means that the degree of creativity is much lower. This is consistent with the provisions of the World Property Rights Organization and the relevant countries and regions regarding laws to protect IC intellectual property rights.

In the area of modes and conditions, protected layout designs should at least satisfy two points:

1. The layout design must have been placed into commercial application. As an industrial product, ICs can have value only through commercial applications, and the result of commercial application is to solidify the protected layout design into an IC chip. This is different from the requirement in the "Copyright Law". Of course, if the layout design is a graphic work, it does not have to be placed into commercial application according to the "Copyright Law", but it can only receive protection from the "Copyright Law". This shows that layout designs have the characteristics of copyrighted objects, but that even more important is that they have the applicability characteristics of industrial property rights objects.

2. Registration procedures must be followed for protected layout designs. This is a prerequisite for IC layout designs to be given protection. Implementation of registration procedures can ensure that the layout design being protected meets certain quality requirements. For this category of protected objects, the interested parties are required to handle registration procedures. Many of the countries and regions in the world that have already promulgated the relevant laws have this requirement. The registration documents can serve as confirmation of their rights over layout designs for the interested parties. At the time of registration, the interested parties are not required to submit relevant samples or the layout designs themselves, so that they may use them the day after they are certified.

The effect and scope of layout design special-use rights are a central issue in protection of semiconductor IC layout designs and people with rights to layout designs and those who use semiconductor ICs and layout designs are extremely concerned with this. They usually feel that the holders of rights over layout designs should have these basic rights:

1. Duplication rights. The holders of rights to layout designs have the right to duplicate or allow others to duplicate part or all of their layout designs. When third persons duplicate protected layout designs without permission, whether they duplicate them in part or in their entirety, this is illegal behavior. Establishing an independent right to duplicate layout designs in the "Semiconductor Integrated Circuit Protection Law" serves to adapt to the trend of an ever more detailed specialized division of labor in the IC industry. In its development to date, the IC industry has gradually divided into the two main parts of design and manufacturing, and many IC design companies hold the status of legal persons. This division is an indication of the maturation of IC industry technology and is beneficial for progress and development of IC technology. Thus, there should be detailed affirmation of this type of detailed division of labor in the law. To fully protect the rights and interests of layout design creators, there must be a special provision regarding this duplication right for layout designs. At the same time, we should also allow the practice of reverse engineering, meaning allowing IC research and manufacturing departments to use dissection of the products of others as a basis for studying and developing newer and better products. Practice has proven that this method plays an extremely important role in promoting the development of IC technology and products. If we simply restrict it to this, the inevitable result will be to suppress development of IC technology. To balance the relationship of the rights and interests of creators and users, and to ensure and promote progress in IC technology, there should be specific limitations on the "know-how" properties of duplication rights, meaning that duplication of the protected layout designs of others purely for analysis and research or for educational objectives should not be viewed as encroachment. Moreover, redesigned and original layout designs resulting from analysis and research on this foundation should not be viewed as encroachment.

2. Commercial rights. Persons having rights over layout designs can themselves or authorize others to place their protected layout designs into commercial applications, and persons holding rights over layout designs can prohibit others from placing protected layout designs into commercial applications without permission. Because the true value of layout designs can only be achieved via commercial applications, if the layout designers do not enjoy this right it will be hard to provide full protection for their rights and interests.

The effect of rights over IC layout designs should be determined by their position in the intellectual property rights legal system, and their effect should first of all be adapted to the laws that provide protection. In addition, they should also be adapted to other laws that touch upon the protection of intellectual property rights for ICs. The direct objects protected by laws to protect IC layout designs are the layout designs. Because the layout designs have their own unique characteristics, their mode of protection enters certain basic principles of intellectual property rights laws, for example the principle of creativity. This makes layout designs as a type of technical program easier to protect. The basic characteristic of the law in being able to balance the relationships among the various primary interests in society is fairness. For the "Semiconductor Integrated Circuit Layout Design Protection Law", on the one hand, it should protect the interests of the creators of layout designs and on the other hand it should take into consideration public convenience in using ICs. A situation of technological monopoly cannot be created in order to protect the rights and interests of persons holding rights over semiconductor IC layout designs.

Moreover, to ensure the application of technical achievements in society and promote technical progress, there should be time limits for the protection of semiconductor IC layout design rights. Within the time limit stipulated in the law, the rights of the persons holding the rights and the income they receive are legally protected. When the legally stipulated time limit has concluded,

however, this technology enters the publicly owned realm and becomes the common wealth of society. Determination of the time limits for protection touches upon factors in many areas, but the primary one among them is balancing social needs with the interests of creators. The history of IC technology development shows that the speed of their development and renewal is extremely fast. For this reason, all countries and regions of the world when protecting layout designs have adopted the method of shorter time limits for protection compared to regular intellectual property rights law. China will protect IC layout designs for a period of 10 years. This time limit basically conforms to the requirements of protecting semiconductor IC layout designs.

In the question of treatment for foreigners, we will adopt the principle of treatment of nationals and look at all international conventions and treaties on protecting intellectual property rights. Most of them adopt the principle of treatment of nationals, and this has become the accepted practice in the realm of intellectual property rights. It should be acknowledged that there are certainly differences among countries in the degree of protection of intellectual property rights. The level of protection is high in the developed countries and lower in the developing nations, and this difference is determined by the national conditions in each country. For protection of intellectual property rights, it should be stated that the protection a country provides for its own nationals is embodied in the most appropriate degree of protection of intellectual property rights that this country can provide during a specific period of time. Thus, it cannot require other countries to provide protection greater than the treatment it gives to its own nationals.

As for other questions related to protections for ICs, the prerequisite for all of them should be not violating the relevant provisions in world protection of intellectual property rights or observing the accepted international practices.

Legal protection for intellectual property rights for ICs is an emerging legal discipline and the development of IC technology requires China to establish and perfect a system of legal protections for intellectual property rights for ICs as quickly as possible. Of course, industrial levels for ICs in China at present are relatively backward, so we should take our actual national conditions into consideration when drafting legislation, meaning that we must protect the rights and interests of semiconductor IC layout design creators as well as take into consideration whether or not this would place artificial restrictions on technical progress. This requires creating an excellent environment for importing advanced technology from foreign countries and attracting investments from foreign countries while at the same time being concerned with protecting the development and progress of industry for our nationality. Protection of IC intellectual property rights is a comprehensive new question and legislation to protect IC layout designs is only a part of this question. As China's intellectual property rights legal system is established and perfected, we must establish an excellent environment for the development of new technology to encourage progress in intellectually creative labor and social civilization.

Progress in Protection of Intellectual Property Rights

92FE0434G ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 3 Mar 92 p 2

[Article by Yang Hong [2799 5725]: "Protection of Intellectual Property Rights in China Progresses"]

[Text] China has recently achieved striking results in the patent, trademark and copyright fields. In 1991, the cadres on the patents front put in major efforts in response to the stipulation of the 10-year economic and social development program and the outline Eighth 5-Year Plan that "the profit system must be fully brought into play and intellectual property rights must be protected," and broke new ground, resulting in new progress in the patent field. Last year, the number of applications handled by the Chinese patent office passed the 50,000 mark and was up 21 percent from the previous year. Since the patent law was issued on 1 April 1985, the total number of patent applications to China's patent office has reached 217,383. Even though China's first patent law came 300 years after England's Monopoly Act, which was the beginning of modern patent law, the absolute number of quantity of patent applications in China is among the highest in the world.

In addition, the utilization of patented technology has yielded remarkable economic and social benefits. Enterprise patent activities are the basis of patent activities as a whole. In recent years, publicizing and popularization of the patent law and the drafting and implementation of relevant policies have promoted the development of enterprise patent activities. In addition, the enterprises' awareness of the importance of patent work has gradually increased with experience. Now, nearly 10,000 enterprises have carried out the "three implementations" of patent leadership, patent organization, and the patent system. Enterprise patent applications account for more than half of all job-related domestic patent applications. In particular, in the last 1 or 2 years, a system for utilization of patents by large and medium-sized state-run enterprises has promoted enterprise development; the patented technology utilization rate in state-run enterprises is significantly higher than that of enterprises under other ownership systems; the representation of state-run enterprises in patent licensing activity has increased greatly, and certain large and medium-size state-run enterprises are expending large sums to purchase patented technology and are promoting enterprise self-development.

In 1991, the Chinese patent office carried out 1582 requested translations and searches, up 10.5 percent from the previous year, along with 1241 computerized searches, 25 percent higher than in the previous year.

Automation in patent documentation services has also made new progress, and the number of computer search terminals has increased from 9 to 13.

As a result of several years' experience, China has had significant achievements in the patent field, but the patent law is not perfect, and timely revisions will be made in it. This is a major document in the development of China's patent system. The Chinese patent office first established a patent law revision team as early as 1988. As a result of several years' thorough research and discussion, suggestions regarding revision of the patent law have taken shape and have been passed by the standing committee of the National People's Congress. A new law will be issued on 1 January 1993.

In addition, there have been many achievements in the trademark field. Protection of trademark rights is the center of the trademark system. The development of a commodity economy is steadily giving rise to enterprise trademark awareness. Attaching full importance to trademarks and their protection has already become a conscious activity in many enterprises. Last year, the trademark office handled a total of 67,601 trademark registration applications, up 10,289 or 18 percent over 1990. By the end of 1991, the effective number of registered trade marks in China was 318,912, including 271,056 domestic trademarks and 47,856 foreign trademarks. The rate of increase indicates that the numbers of applications and registrations are at a historic high.

Trademarks are a product of the commodity economy, and as the commodity economy continues to develop in China, we must make major efforts to increase enterprise commodity awareness as rapidly as possible. Industrial and commercial administration and management departments throughout the country have made use of symposia, expositions and other methods suited to local conditions to publicize the subject widely among the enterprises and in society, and have achieved excellent results. China's work on revision of the trademark law in order to adapt to the new situation in the development of the commodity economy is also proceeding smoothly. A draft of a revised trademark law is already essentially complete.

Last year, the PRC Copyright Law was in its first year of implementation, and as a result of joint efforts by the state copyright office, the copyright administration and management organs throughout the country, other relevant departments and all persons concerned with the protection of copyright in China, copyright protection has also achieved gratifying results and the development of the copyright protection system in China has been energetically promoted.

Exploring Technology Innovation with Chinese Characteristics

92FE0434E Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 23 Mar 92 p 3

[Article by Yang Tingfang [2799 1656 5364], Huang Nianzeng [7806 1819 2582], and Chen Hongyu [7115 1347 1946], staff members of KEJI JINBU YU DUICE [S&T PROGRESS AND POLICY]: "Some Thoughts on Chinese-Style Technology Innovation"]

[Text] Since it was brought to China, the theory of technological innovation has been the subject of increasingly close attention. There are many enterprises that, while not thoroughly understanding the content of the term "technological innovation," are engaging in the actual activities of guiding and organizing enterprise technology development, importation and absorption, assimilation and innovation, production management, operations and scales, and post-sale service; whether consciously or unconsciously, they are actually, practicing, utilizing, and even constructively applying the theory of technological innovation.

Even though people distinguish technological innovation from technological modernization, technological upgrading, and technological invention, they still regard as somewhat unfamiliar such theories and concepts as product innovation, process innovation, management innovation, organizational innovation and system innovation, which are generally implied by the term "technological innovation." The theory of technological innovation originated and developed in the west; it requires a certain process of absorption and assimilation in China and must itself be subjected to a kind of Chinese-style "innovation."

Correctly Understanding "Technological Innovation"

Technological innovation is not a narrow concept. As viewed by Schumpeter, "innovation is the process of continuously renewing the economic structure from within, i.e., of continuously breaking down the old and continuously creating new structures. It includes five specific elements: (1) importing new products, (2) importing new technologies, i.e., new production techniques, (3) opening up new markets, (4) controlling new sources of supply of materials, (5) instituting new types of enterprise organization." This "innovation theory" of Schumpeter's is accepted internationally and has become the theoretical criterion that guides technological innovation. From this point of view, technological innovation affects practically all aspects of the production process and thus is also expressed in all steps of economic development, rather then merely being a matter of science and technology proper.

In order to participate in the international study of technological innovation, many people in this country have accepted the definition that "technological innovation is an integral process, extending from the conception and development of new products and processes to market applications, which includes the origination, development and commoditization of new concepts."

We believe that innovation activities can be understood at the microscopic level as the development of new products or processes, at the intermediate level as the industrialization of high technology and new technology, and at the macroscopic level as industrial activity. But

the theory of technological innovation is in reality a theory of the innovation of social productive forces. This is the only way to grasp its essence, to guide technological innovation activity, and to clarify the misconception that technological innovation is merely the concern of the scientific and technological departments.

Marxism holds that the history of society is first and foremost the history of the development of productive forces and that in the long river of human history, there is a continual replacement of old productive forces by new ones and a continual supersession of the old by the new, in which science and technology always play a vanguard role. As history entered the 20th Century, science and technology entered the age of electrical equipment and the atom. Today we have progressed further, to the age of electronics and the information age, and in the course of this rapid change, electronics technology has permeated all aspects of life, biotechnology, deep-sea mining, computer technology and space technology have extended and expanded man's limbs and brain to an astonishing degree, and society's productive forces have reached unprecedented heights.

As a result, the history of technological innovation is in reality the history of continuous innovation, continuous progress, and continuous rapid advance of human productive forces. Furthermore, the history of technological innovation is also the history of the transformation of production relations and of the superstructure, and of the advance of human spiritual culture. If iron implements had not been invented, primitive society would not have collapsed and slave society would not have appeared; if it were not for the steam engine, the feudal monarchy could not have been brought down; without mechanized large-scale industry, the production relations of capitalism could not have been consolidated and developed and the material conditions for the socialist revolution would not have existed. Similarly, without Newtonian classical mechanics, Maxwellian electromagnetic theory, Euclidian mathematics, and the modern revolution in physics represented by Einstein, there would not have been modern education and the spiritual style of the new schools and civilization. Without these factors, we would still remain benighted in barbarian darkness. Once we recognize that science and technology are the primary productive force, we must also recognize that technological innovation is the primary driving force of historical and social development. Only with this realization can be begin to discuss Chinese-style technological innovation.

The "One-Two-Three" Model of Chinese Technological Innovation

Whether we speak in terms of the innovation of productive forces or use the general terminology of technological innovation, we believe that China's technological innovation strategy must in overall terms follow a "one-two-three" model.

"One" Refers to a Single Goal, the Unification of Technology

We must promote the intimate integration of science and technology with the economy, vigorously utilize science and technology as the primary productive force, accelerate the dissemination and application of scientific and technological achievements, and bring about their commoditization and industrialization.

Comrade Jiang Zemin has stated that genuinely shifting economic construction to a reliance on scientific and technological progress and raising the workers' qualifications constitutes a further deepening of the shift in focus decided at the Third Session of the Eleventh Central Committee and will advance this shift to a higher stage. In today's world, the influence of science and technology has already penetrated to every area of social life, and changes are taking place in people's modes of thinking, acting and living. The concepts of value and morality are also being attacked. In particular, in the international competition in overall national power, the key is the competition in science and technology, and whoever falls behind in science and technology will be beaten. Consequently, the primary matter in the change of orientation of economic development is the thorough utilization of the immense role of science and technology as the primary productive force, relying on scientific and technological progress to raise the quality of China's economic growth and to increase our overall national strength.

China's agriculture has not yet thoroughly cast off the production mode of the natural economy, and per-capita grain output is only 6.6 percent that of the United States. We must feed 22 percent of the world's population with 7 percent of the world's arable land, and simply investing more labor in the extensive development model offers no solution. In industry, most enterprises are still in a high-labor-input, low-output state. China's energy consumption per $10,000 of output is 6.1 times Japan's level and 2.3 times the US level. These energy-consuming, resource-consuming, extensive approaches to expanded reproduction will no longer suffice. According to the Douglas equation, which is used throughout the world, the contribution that technological progress makes to economic development is an average of 49 percent in the developed countries and as high as 60-70 percent in certain countries; in the developing countries it is an average of 35 percent, and in the 10 years of reform and opening to the outside in China it has been only about 30 percent. Thus, reliance on traditional methods of development will not enable us to achieve the second strategic objective of China's economic development. Economic development must change its path and must rely on scientific and technological progress; it must unify science and the economy and guarantee the implementation of the second-stage strategic coals.

Under the guidance of this major policy decision by the central party authorities, during the 1980's we achieved more than 200,000 major scientific and technological

results; those that won state awards created more than 280 billion yuan in economic benefits. In particular, since 1988, when governments at all levels closely integrated the implementation of the Spark Plan, used science and technology to invigorate agriculture and to vitalize markets, and relied on technology to vitalize industry, there has been progress in converting high technology to commodities and to industries. More than 30 large and medium-size cities that had advantages in S&T and in human resources, or that were in coastal areas and were able to open to the outside, established high-technology and new-technology industry development zones. The development of this situation unquestionably is of major strategic importance for China's economic growth and for an increase in our national strength. Just as the shift in the focus of effort guaranteed the implementation of the first-stage strategic objective, the unification of science and the economy will certainly guarantee the victorious implementation of the second-stage objectives and will lay a solid foundation for the implementation of the third-state objectives.

"Two" Refers to the Dual Mechanism of Plan Guidance and Market Guidance

China is a socialist country, and implementing the planned commodity economy system dictates that while increasing the government's capabilities for regulating science and technology, so that science and technology will promote an increase in economic strength, we must organically integrate the advantages of the plan and the market. As a consequence, the operating mechanism of Chinese-style scientific and technological innovation activities should be dual guidance by the market and by state S&T policy. The state plan and policy guidance orient activities in the S&T field toward economic development, painstakingly nurture and organize S&T markets, use technology supply and demand to fuse S&T and the economy, and make it clear that under the socialist planned commodity economy, technological results are also commodities, thus establishing a compensated transfer mechanism in accordance with the law of value and the contracting method.

Because China's development is imperfect and market behavior is abnormal, certain commodities that are in extremely short supply, such as power and raw materials, have not yet escaped from the operating model of the scarcity economy; in addition, many manufactured industrial products are of poor quality and the enterprises are losing large amounts of money. In terms of plan management, control is still too rigid, and direct quantitative management has penetrated to all aspects of enterprise operations; in terms of taxation the policy of "whipping the faster ox and protecting the slower" continues to be practiced as before. From this viewpoint, market guidance pursues only immediate benefits, and market signals are distorted, which is harmful to continuing technological innovation; the practice of "guaranteeing revenues and guaranteeing livelihood" in the plan and an excessively rigid quantitative control have also strangled enterprise initiative, so that people have no time to think about technological innovation. Thus, in order to make market guidance and plan guidance produce a positive effect, we must quickly institute major reforms. First, we must nurture a full-fledged market system and gradually standardize market regulations as a prelude to fair competition, so that the enterprises will want to maintain and develop management and technology; on the other hand, the plan must be used to correct the short-term behavior of the market. Thus, plan guidance must gradually withdraw from the day-to-day operations of enterprises and focus on S&T development programs for long-term benefits, or, in other words, the plan must be able to guarantee a continuation of the manpower, material and financial resources that are essential to major technological innovation and fully utilize the advantages of centralized nationwide planning under socialism. At the same time, the state must make benefits the core concern, draft science and technology policies, and guide technological innovation: in order words, the state should specify what should be developed, what should be limited, and what should be abandoned, and enterprise activities bringing about scientific and technological innovation should be subject to scientific prescription.

"Three" Refers to the Tripartite System of Research, Production, and Marketing

The reform of the S&T system is a component of China's overall reform and opening to the outside and is a major project that complements the economic reform of the economic system. Since 1985, when research organizations entered the economy via the form of diversified operations, the situation as regards the integration of science and technology with the economy has been totally transformed. More than 10,000 unified science-industry-trade (or science-agriculture-trade) research and production groups have appeared. Experience shows that the unified research, production and marketing operations of these industry groups have promoted the technological modernization of traditional industries and have become the point of growth of the high-technology and new-technology industries. At the same time, numerous private research organizations set up by scientific and technological personnel on the basis of self-funding, voluntary association, autonomous operation, and independent profit-and-loss management have developed rapidly. These enterprises and enterprise groups are an effective organizational vehicle for technological innovation activities, and they have already become a vigorous force promoting the dissemination of technology, the readjustment of industry structure, accelerated conversion of technological results to commodities, and the development of high technology and new technology. This system forcefully demonstrates the effect of development and operation of technological innovation activities.

The Chinese-style model for technological innovation activities or production-force innovation activities that we have sketched out already has many successes to prove its validity and is steadily being improved. If we

proceed in terms of China's circumstances, borrow from western theory of technological innovation, absorb its essence, and develop Chinese-style innovation of productive forces, we are sure to be able to promote effectively China's economic development and social progress.

Guangdong's Strategy of Internationalizing High-Tech Industries

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[Article by Wei Xulin [7614 4872 2651], Qiu Rongsheng [8002 2837 0524], Cai Qixiang [5591 7871 4382], Guo Xiquan [6753 0823 3123], and Liang Zhiyao [2733 1807 5069]: "Guangdong's Strategic Choices for Internationalizing High-Tech Industry"]

[Text]

I. Export Guidance Strategy

In developing its economy, Guangdong has adopted an import substitution strategy of importing advanced technology from foreign countries and then digesting, absorbing, and improving it and developing domestic production while at the same time restricting imports of similar products that can be produced in China. This import substitution policy has played a positive role in accelerating technical upgrading of traditional industry in Guangdong and spurring development of its national economy and raising of its technical levels. However, it is hard for an import substitution strategy to play a relatively major role in the development of high-tech industry. The experience of many countries and regions shows that when import substitution and low efficiency economic mechanisms within a country are integrated, the result is often that people do not think about pressing forward under protection by tariff barriers, which results in enterprise products having poor quality and high prices, low production efficiency, and weak competitiveness. Adopting this type of strategy to develop high-tech industry would cause high-tech industry in Guangdong Province to crawl along permanently behind the developed nations. High-tech industry is knowledge-intensive and capital-intensive industry and is characterized by rapid changes and short profit cycles. Often, when a certain imported high technology is still at the stage of samples being studied for a shift to domestic production or of products having just entered the market and still not having opened up sales avenues, the time has already passed. Thus, when Guangdong is taking the path of internationalization to develop high-tech industry, it should resolutely implement an export guidance strategy of importing high-tech from foreign countries or utilizing high-tech achievements made within China and use the international market as a guide to develop high-tech products and compete in the international high-tech market. This can enable Guangdong Province's high-tech products to enter the international market directly, compel enterprises to carry out production and management activities in accordance with international quality standards and accepted management practices, and enable the development of high-tech industry in Guangdong Province to have an even higher starting point. This would spur rapid improvement of product quality in high-tech enterprises and improve administration and management to adapt to the high standards and strict requirements of international market competition.

II. Multinational Management Strategy

Because the strategic development space of high-tech industry is the international market, during the process of gradually expanding their management activities, high-tech enterprises should establish strategic outpost base areas in foreign countries according to conditions and in a planned manner, encourage large enterprises and enterprise groups that have the proper conditions to invest in high-tech companies in foreign countries and even purchase high-tech enterprises in foreign countries, use them to import foreign capital and foreign technology into Guangdong Province, and utilize sales channels of companies in foreign countries to develop in the direction of multinational companies and international commercial organizations and gradually take the route of multinational administration. This would enable Guangdong's high-tech enterprises to gain direct decision-making rights over opening up markets and developing toward the outside world. It would help in circumventing trade barriers in importing countries, reduce production costs, and increase our competitive capabilities. It would also aid in collecting market information and feedback information and in improving products to make them better adapted to market avenues.

In the long term, to make Guangdong's high-tech industry truly move toward the world and gain a favorable status in the new international division of labor, we must establish our own multinational companies and implement multinational administration. Thus, all of our large and medium-sized enterprises and enterprise groups whose high-tech products are definitely competitive in the international market should gradually establish their own administrative organizations in foreign countries. They can begin by establishing sales and service organizations in foreign countries and go on to establish assembly workshops or branch plants in foreign countries, and then establish production base areas in foreign countries. They can use various types of investment in foreign countries to develop their own sub-company systems. For this reason, local governments should adopt support measures to make those key large and medium-sized enterprises and enterprise groups that produce high-tech products gradually develop into international enterprises having a substantial scale. Besides making investments outside of China to open up the international market, they should also make direct use of the capital, technology, and management knowledge of the countries and regions where they are located, jointly manage local enterprises or institutions, and market

enterprise products locally. In the 34 joint investment production enterprises established in the United States and the Hong Kong region by the Shenzhen Special Economic Zone Development Company, for example, all of the capital was raised from local banks and they did not use a single cent of foreign exchange from within China. This provides valuable experience for Guangdong Province to use international capital directly to develop multinational administration.

III. Joint Competition Strategy

Facing the new situation in the international market that appeared in the 1990's of even greater monopoly and more intense competition, it will be very difficult for Guangdong's high-tech industry to engage in rivalry in the international market by relying on a single medium-sized or small enterprise to go out and compete. Thus, we must take the route of joint competition. Joint competition can to a certain degree transform the inferior position of weakness of Guangdong's enterprises to form local relative advantages. This is particularly true of the need for integration with enterprises that sell similar products in foreign markets to attain the goal of jointly cornering markets. The form of the joint competition can involve integration of certain enterprises that manage similar types of products or related products, or it can involve cooperation between high-tech companies in the interior of China or in foreign countries to establish export-oriented enterprise groups whose primary objective is the development of high-tech products and establish multinational management service organizations in foreign countries. The experience in China and foreign countries shows that establishing export-oriented enterprise groups is an important way to spur the development of high-tech industry and progress in its internationalization. Japan's high-tech industry has developed very quickly, and one of the key factors behind this rather strong international competitiveness is the existence of large numbers of export-oriented enterprise group systems like Mitsubishi, Mitsui, Sumitomo, and so on. These enterprise group systems stretch across many different industrial sectors and enable enterprises in the group to share information, provide mutual support, and reduce the risk for R&D. Moreover, because most of the top-notch S&T personnel in Japan are concentrated in the enterprise groups, the high-tech products of these enterprise groups are highly competitive in both the domestic and international markets. The enterprise groups have become the main force in Japan's development of high-tech industry and participation in international competition. During the past several years, Guangdong Province has also established several export-oriented enterprise groups whose objective is the development of high-tech products. An example is the Shenzhen Saige Group, which has made prominent contributions to optimizing product mixes, opening up international markets, and exploring multinational administration. For this reason, we should actively encourage large traditional enterprises in Guangdong Province to invest in high-tech industry and develop high-tech products, gradually form high-tech enterprises, and use these enterprises as the backbone force to continue gradually establishing high-tech export-oriented enterprise groups in a continuing sequence. At the same time, we must create the conditions to enable enterprise groups to play their role fully. Toward the outside, for example, we can give export-oriented high-tech enterprise groups direct import management rights and allow them to join together with export enterprises that have related products to form relatively strong group competition abilities. Toward the inside, expand the investment rights and joint venture rights of key enterprises and encourage scientific research organizations to enter enterprise groups to improve the technical innovation capabilities of enterprise groups. In enterprise integration and cooperation and in expanded competition in foreign markets, gradually move into foreign countries and establish points and run plants, and develop in the direction of huge multinational enterprises to increase our competitiveness in international markets.

IV. High-Level Import Strategy

Imports of technology, equipment, capital, and skilled personnel are important aspects of internationalizing high-tech industry. In particular, technology imports are a way for countries and regions to save scientific research and trial manufacture investments and time and promote S&T progress and economic development as quickly as possible. However, low-level redundant imports not only create waste but also lead to our remaining forever behind others. Thus, regarding the development of high-tech industry in Guangdong Province, we must adhere to a high-level import strategy and use products that will sell well during the 1990's and even into the next century and S&T development in Guangdong Province during the 1990's, especially high-S&T development, as a strategic focus for importing modern technology, equipment, capital, and skilled personnel. Forecasts by the relevant departments indicate that major breakthroughs will be made in microelectronic technology, new materials technology, biotechnology, and other high technologies during the 1990's and that through further application and commercialization, they will gradually form a powerful industrial force that will corner the world market over a large area. Forecasts by the relevant companies in the United States indicate that in the 21st Century the electronic communications industry, data communications system industry, consumer electronics products, high-level materials, and automation systems will be the five star industries. Guangdong Province's S&T development strategy for the 1990's will be focused on large agricultural technology, resource development and utilization technology, electronic information technology, bioengineering, new materials, refined chemical industry, electromechanical integration, new energy resource technology, high-tech in the light and textile industries, key technologies for social development, and other S&T realms. For these key technological realms, we must set

our sights on the newest technical achievements in these fields that appear in developed countries, break through technology barriers, and selectively import strategic items that have major applications prospects for industry. When we are considering using imports to develop high-tech industry in Guangdong and readjusting our industrial structure, we must consider whether or not the imported items are coordinated and consistent with our technical levels and Guangdong Province's S&T development strategy. We must do qualitative and quantitative research on strategic items, integrate with plans, and have focused development. Only high-level S&T levels and industrial forces can enter the realm of multinational administration and participate in international competition.

V. High-Level Development Strategy

Although technology imports are one way to raise our starting points in R&D and production manufacturing, they are to an even greater extent a source and channel for digesting, absorbing, and innovating. They cannot be considered the sole route to developing high-tech industry and we cannot think about "buying a high-tech industry". Economic competition in the modern world is in essence competition of science and technology, and the focal point of S&T competition is on competition in realms of secret technology that have not been made public. High technology, which is a reflection of the newest S&T achievements of the modern age, is the general name used for this type of secret technology and it cannot be bought in international markets. Thus, the guiding ideology for technology imports to develop Guangdong's high-tech industry should be based on development within China and using imports of key technologies along with digesting, absorbing, and innovating to gradually form our own high-tech patents and gradually develop and establish our own high-tech industry. Importing and developing are two aspects of synchronized development of high-tech industry. About one-third of new investments in Japan are used to develop new products. Given Guangdong's shortage of capital, technology, and development conditions, however, there is an even greater need for concern about rational directions for investment of capital and technology to concentrate forces for R&D on strategic items for high-tech industry. Use importing from abroad and cooperation with units in the interior, integrate imports with development, and other patterns to absorb capital and technology from within China and from foreign countries and concentrate them to develop Guangdong's "Torch Plan" projects. In product research, we should pay attention to trends in consumer demand in the international market and forecast development trends, focus on light industry, quick profit, short schedule, and limited supply products, and focus on time-saving, labor-saving, energy-conserving, high efficiency, and convenient products, and on product sanitation, safety, and performance standards. We should also be concerned with materials, costs, and resource conservation in product development and the question of environmental protection. Forecasts indicate that there are broad market prospects for non-stop electronic computers, voice recognition answering systems, plant data collection systems, electronic computer variable resistors, data collection control and monitoring devices, and other types of products. When developing similar products, we must give comprehensive consideration to whether or not they benefit strategic shifts and market responses in industry.

VI. High-Speed Shift Strategy

Although foreign trade and exports have developed quickly in Guangdong Province during the past several years, a look at the commodity mix shows that the proportion of elementary products is still very large and that most industrial finished products are also popular goods of dependable quality, while the proportion of high and new-tech products is still very small. Because the technical makeup of export commodities is relatively low, exports to earn foreign exchange still rely on scale benefits, which has greatly affected levels of enterprise foreign exchange earnings from exports. For this reason, we first of all must change the industrial model of enterprises (from a labor-intensive model to a technology-intensive model) to promote progress in readjustment of the export product mix, and we should give consideration to strategic shifts in industry. Our strategic shifts should include at least these aspects: One is rapid conversion of imported and developed technical achievements into forces of production. The second is rapid conversion of forces of production into commodities and their immediate placement into the market. A third is to shift abandoned industries or labor-intensive industries into the interior of China or into low-level substandard enterprises in continually pursuing rationalization of our industrial deployment. The Zhujiang Delta, special economic zones, and open cities along the coast should use high technology and high added-value products and use large amounts of electromechanically integrated products with a high degree of a shift to domestic production to transform our irrational export product mix. The focus during the 1990's is on developing exports of several electronic information products, light and textile industry high-tech products, electromechanically integrated products, refined chemical industry products, and biotechnology products, and using comparative benefits from international market trends and strategic management patterns to spur the development of high-tech industry in Guangdong Province.

VII. High Intelligence Investment Direction Strategy

The world's new technological revolution has now permeated many realms. The rapid development of high-tech industry has upgraded traditional industry, the degree of production automation has becoming increasingly higher, and there have been corresponding changes in the industrial structure and labor force structure that have resulted in an obvious increase in the demand by

production for mental labor and understanding new production skills on the part of laborers. Thus, to adapt to the changes and requirements of the future industrial structure and intelligence structure, we must be concerned with the high intelligence investment direction of skilled personnel. Examples include digital technology personnel, laser technology personnel, database management personnel, bioengineering technology personnel, and many others that are utilized in great numbers in emerging industries. Estimates by the United States Electronics Industry Association indicate that by the year 1995, there will be a 97 percent increase in demand for computer service personnel compared to now, and 10 years from now the world will need 1.5 million robot engineering specialists. To achieve Guangdong Province's strategic objectives of changing industrial models and multinational administration of high technology, we must rapidly carry out high intelligence training of high-level management personnel, technical personnel, foreign trade management personnel, and even high-tech industry workers to use multi-level, multi-function, highly-integrated, and highly-adaptable modern personnel groups to go and win in new development.

VIII. Multielement Market Strategy

Internationalization of high-tech industry means making the world market as a whole the stage for administrative activity and the strategic development space for enterprises. Although the overall principle for the deployment of Guangdong's export market is to "have a global orientation, consolidate Hong Kong, open up eastern Jiangsu, and march toward Europe and the United States", because of different development levels and differences in demand in each country in the world, we must do our opening up according to different conditions in the markets of different countries.

The developed countries are the primary trade markets for high technology and its products. Statistics show that the developed countries, which have only 20 percent of the world's population, have concentrated more than 80 percent of the world's wealth and more than 95 percent of its S&T forces. The developed countries are the primary exporting nations for high-tech products as well as the primary importing nations for high-tech products. Their export volume accounts for more than 70 percent of the total volume of exports from the capitalist countries, while their import volume accounts for about 50 percent of the total volume of imports in the capitalist countries. For this reason, the developed countries are the primary markets that we should work on opening up. Exporting high technology and its products to the developed countries will help improve China's status in foreign trade and make China more competitive in international markets. At the same time, we can use the high technology that China has developed to replace technology whose export the developed nations have restricted. Because of the relatively high technical performance and quality requirements for products in the developed countries, and because the developed countries are the markets that emerging industrial nations must compete for, the competition is rather intense and it will rather difficult for Guangdong's high-tech products to move into this market. Looking at the current distribution of sales markets in foreign countries for Guangdong Province's high technology and its products, the market in the developed countries only accounts for 27 percent of Guangdong's total sales of product varieties in foreign countries. For this reason, Guangdong Province's high-tech products must still strive to open up this market.

While the emerging industrial nations and regions, referring to the "four small dragons of Asia" [Hong Kong, Taiwan, South Korea, and Singapore], do not have the economic technology and market capacity of the developed countries, they are advanced compared to the developing nations and they are close geographically to Guangdong Province. They are the primary export trade markets for Guangdong's high-tech products at the present time (in 1989, for example, they accounted for 41.7 percent of Guangdong Province's total export sales of high-tech product varieties). For this reason, we should continue to develop and consolidate this market.

The developing countries have vast territories and large populations, but relative shortages of materials and weak industrial and commercial foundations. Thus, they are not at the present time the primary market for high-tech and high-tech products but are instead the primary market for technology and its products to be used in industrialization. Because overall levels of high technology and its products in Guangdong Province at the present time are not high compared to the developed nations and our prices are comparatively cheap, they are more appropriate for developing countries. The nations of Southeast Asia in particular have considerable interest in high-tech products from Guangdong Province. In 1989, for example, Guangdong's sales of high-tech products to developing countries accounted for 28.2 percent of Guangdong's total export trade volume of high-tech product varieties during that year, and sales to the countries of Southeast Asia accounted for 18.4 percent of this. Thus, at the present time the developing countries and in particular the nations of Southeast Asia are one of the primary markets for Guangdong Province's high-tech products as well as a market that we should continue to open up and consolidate for Guangdong's high-tech and its products.

IX. Multimode Marketing Strategy

Based on different conditions in the world market, Guangdong can choose among the following strategic modes to internationalize the marketing of its high- tech industry.

1. "Design in foreign countries—processing in China—international markets". The developed countries have powerful technical innovation capabilities but processing costs are high. Although the designs for many products are very advanced, their high prices have

weakened their competitiveness in international markets. If we integrate advanced designs from foreign countries with the low cost of technical processing in Guangdong, the products would be more competitive in international markets and both sides would profit. The main products that can adopt this arrangement are electronic instruments, communications equipment, electronic computers and software, and so on.

2. "Loose parts from foreign countries—assembly in China—international markets". Several countries in the European Community have stipulated that there can be tax reductions and exemptions for fully assembled units imported from China, and the prices for full units imported from China are also inexpensive. China can take advantage of its low processing costs, import parts and components from Japan and the United States, process and assemble them into complete units within China, and sell them in the Western European market. This would mean that we would import raw materials from locations with the cheapest prices, process them at locations with the cheapest labor costs, and then sell them in markets where selling prices are higher. The main products appropriate for this type of arrangement are computers, sound recording equipment, office automation equipment, communications systems, and so on.

3. "Chinese technology plus foreign capital and equipment—production in China or foreign countries—international markets". Because Guangdong Province has the advantages of being located on the coast, adjacent to Hong Kong and Macao, and having the interior of China at its back, we can use importing from abroad and cooperation with units in the interior, take advantage of the S&T achievements and skilled personnel in the interior of China, integrate with capital and equipment in foreign countries, make joint investments and cooperate in developing high-tech products, and use marketing channels of foreign businesses to put our products into international markets.

4. "Integrated design and development, cooperative production". To open up high-tech markets, many plants and businesses in foreign countries are quite willing to use the products of their country in conjunction with special market designs and technologies to open up sales avenues. Guangdong Province can use its own unique customs and aesthetic concepts to attract the interest of plants and businesses in foreign countries for joint investment and cooperation. This would also help us obtain advanced equipment and technology, and would allow us to use the sales networks of foreign businesses to open up product sales avenues.

5. "Use imports to develop exports, integrate imports and exports". Concretely speaking, two arrangements can be adopted. One is to import key equipment from foreign countries, assemble it in China, and then sell complete sets of equipment to nations of the Third World. The other arrangement is to import technology from foreign countries, combine it with China's unique resources, sell the products in international markets, and use technology from foreign countries to promote the export of China's high-tech products.

6. Implement systematic supplies. Given the high degree of technology intensity of high-tech products, they can operate only with a complete and unified control system to carry out automatic management. Moreover, users also want to use parts and components made by different plants and businesses to assemble complete sets of equipment and to purchase them wholesale from a single plant or business. Systematic supplies require that customers be supplied with complete sets of equipment and that they assume responsibility for all guarantees of product quality (including the quality of products produced by the assembled equipment), and they require the provision of a series of decision-making programs. This type of arrangement is best suited to large enterprise groups that have a rather good foundation for developing and producing high-tech products.

7. Establish scientific research centers and engineering and technology consulting centers in foreign countries. To expand sales of high-tech products, enterprises in Guangdong that have the proper conditions can establish scientific research centers and consulting centers in foreign countries. Buyers can send their own experts to work in these centers and the buyers' experts can assume independent responsibility for development work and then turn over the achievements they study to Chinese enterprises for production. This unique type of marketing arrangement can satisfy the requirements of buyers to the greatest possible extent and greatly reduce development schedules. Product prices can also float up or down according to the degree to which customers participate in development. Adoption of this method can enable enterprises in Guangdong Province to gain an even greater understanding of the newest trends in foreign markets, make immediate readjustments in production, and use cooperation with enterprises in foreign countries to raise research levels.

8. Set up plants outside of China. Investing to build plants or purchase companies outside of China can take advantage of local technical equipment and skilled personnel resources, produce and sell locally, enter the central zone of world high-tech industry, extend our feelers, and obtain technology and information, which could break down technological blockades by advanced countries and avoid trade barriers in the developed countries, to keep pace with world high technology.

9. Multinational administration. Establish multinational companies centered on technology management activities, adopt transfer sales or directly establish branch companies in foreign countries, and transfer out high-tech products along with mature technology and investments "wholesale". High technology from the United States, for example, is continually transferred via routes in Europe, Latin America, and Asia, which protects its industrial property rights, thereby maintaining its technological vanguard status, and it obtains the fullest profit and income.

10. Diversified technical services. The field of technical services in international high-tech product markets is continually expanding. Technical service fees now account for more than 50 percent of the price of many types of automated equipment. Technical service projects include equipment selection, program design, software compilation, management personnel training, and other aspects. If Guangdong Province's high-tech enterprises truly wish to move toward the international market, they must begin now in collecting several first-rate technical service personnel and conduct systematic training in this area before they can gain a solid foothold in the intense competition.

*This article was selected from part four of the Guangdong Province Science and Technology Commission's key soft science research project "Research on Internationalization of Guangdong's High Technology" research report. Liang Zhuokai [2733 8743 2818], Fang Xuan [2455 2467], Zeng Xiangxiao [2582 4382 2400], He Yongqing [0149 3057 3287], Liu Wenyan [0491 2429 3508], Ye Minhui [0673 3046 6540], Zhong Xiaoshan [6988 2556 1472], Ouyang Suiqing [2962 7122 4482 7230], Zhang Jinsheng [1728 6930 3932], Xu Maoyuan [6079 5399 0337], Lin Lijian [2651 0500 0256, and Zhang Qingzhu [1728 1987 4376] also participated in this topic.

Zhou Guangzhao Urges Cooperation Between Research Institutes and Industry

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[Text of Speech by President of Chinese Academy of Sciences Zhou Guangzhao [0719 0342 0664] at the Symposium on Using Science and Technology to Promote Economic Development: "Establish the Mechanism for a Beneficial Cycle of Cooperation Between Scientific Research Units and Enterprises"]

[Text] Since the State Council held the National Enterprise Technical Progress Conference at the end of last year, the question of how to thoroughly motivate China's scientific and technical personnel and to promote technological progress in large and medium-size enterprises and the readjustment of China's industrial structure has become a subject of attention in China's S&T circles and throughout society. The China Academy of Sciences, the State Council Development Research Center and the newspaper GUANGMING RIBAO now are jointly holding this symposium on the Use of S&T to Promote Economic Development in the hope that in company with comrades from large and medium-size enterprises, the scientific research units and the relevant departments, we can analyze the current situation, summarize the experience of all parties in the last few years, and jointly search for a way of using science and technology to promote enterprise technological advancement that is consistent with China's national circumstances.

The problem of integrating science and technology with the economy is a matter of primary importance that China's S&T system reform must solve. In the years since reform and opening to the outside were instituted, the CAS and all other research units throughout the country have devoted major efforts to it. In 1987, the CAS explicitly issued academy operating guidelines specifying that the main force would be committed to the principal battlefield, namely, China's economic development. It also took steps to organize and guide all scientific and technical personnel in serving economic development under a variety of forms; these have included various types of technological and economic cooperation with large and medium-size enterprises, industry departments, and the provinces, municipalities and localities, such as organizing the Yellow River-Huai River-Hai River joint effort, providing enterprises with specialized technology and engaging in their technological modernization, joint creation of high-technology enterprises and the like. Certain comrades from the CAS who are present here today represent organizations that have achieved definite successes in these areas. But we are well aware that this problem is far from being solved and that it involves certain problems of the deeper hierarchical levels of the current system structure.

The first problem is that of the system itself. China's S&T system and economic system lack an effective interface. These two systems have been relatively separate for a long period, and as a consequence, the enterprises' technological requirements and the research departments' S&T results generally must be coordinated at the national level or the ministry or commission level. Owing to the inability of enterprises and research units to interface directly, the research organizations do not understand enterprise needs or market requirements and they feel that there is no scope for their abilities in these areas, while the enterprises believe that China's main S&T forces are divorced from the main battle front and that there is no organization that they can rely on. To solve this problem, we must rely on increasingly thorough system reform, and the comrades of our science organizations and our enterprises must make a joint effort to create more opportunities for mutual understanding and cooperation. We hope that at meetings such as the one being held today, the comrades of the two sides will be able to sit down together, communicate, exchange experience, hold an in-depth joint discussion of the problem of the deep hierarchical levels of the S&T and economic systems, and consider ways and means of coordination between S&T and the economy.

A second aspect is that the disposition of China's S&T forces is not geared to the needs of the country's economy development. A characteristic of China's S&T dispositions is that the research forces of the CAS and certain departmental academies and institutes are comparatively strong and are at a rather high hierarchical level, while the enterprises' S&T forces are relatively weak and we cannot find a fully suitable point of linkage. The enterprises everywhere believe that although these

research organizations produce good results, they are difficult to utilize and assimilate, and that direct importation of foreign sets of equipment is quicker. The research organizations believe that enterprise demands are too harsh and that the research organizations are required not only to produce laboratory results, but also to carry on small-scale, intermediate-scale and production-scale tests which the enterprises ought to do themselves; they feel that they are in the difficult position of not being able to do all that they would wish. To solve these problems, not only must the state gradually make the necessary readjustments in the disposition of S&T forces, but the research organizations and enterprises must intensify personnel exchange and information exchange and jointly find the best interface. The research organizations and enterprises should both take the initiative in closing ranks. Where it is capable of doing so, the CAS has set up some intermediate-scale testing bases and is preparing to establish engineering centers. The enterprises must strengthen their own intermediate-scale and production-scale testing capabilities and increase their abilities to absorb and assimilate domesetic S&T results.

Third, and most critical, we must establish a favorable cycle of cooperation between research units and enterprises that is consistent with China's conditions. In the past, the CAS has made considerable efforts in support of economic development; its basic model has been that the enterprises utilize scientific and technical results in accordance with the state plan and the scientific organizations rely on funds allocations to solve major scientific and technical problems of China's economic development. This system and method have been unable to adjust to the high level to which S&T are developing and to fierce market competition; and the S&T sphere and the economy have not been able to cooperate closely and to create a beneficial cycle. Cooperation must be based on mutual benefit if it is to be lasting. The research organizations and enterprises must create a beneficial cycle, the enterprises must increase their benefits by continuously absorbing technology, and the research units must be able to raise their own research capabilities by technology transfer, so that the two spheres promote each other and develop in coordination. Setting such a beneficial cycle in motion is difficult. The best interface is the market, and only regulation by the market mechanism and common effort under the guidance of the state plan will make give rise to such a mechanism in China. A conceptual problem must be solved here: we must break down the departmental ownership system, and everyone must act in terms of the overall situation. The CAS is willing to start the process itself. We have an important point of vantage from which to view reform: the CAS is a national academy of sciences, not a department, and it should have no departmental interests, but should proceed in terms of the overall national situation. We have made some efforts in this direction in the last few years, such as establishing development laboratories and setting up a nationally oriented science fund, and we have had rather good results. Recently, as a result of repeated research, we decided to accede to the request of the State Council Production Office and further mobilize CAS personnel and organizations for an integrated project oriented toward enterprise technological advancement. We hope that when the conditions mature, several production-scale test facilities will be set up in the CAS and will be open to the entire country or to certain industries, welcoming enterprise S&T personnel who wish to perform research there and welcoming the enterprises' suggestions of S&T projects for joint investigation. We are also willing to use our research capabilities to help enterprises establish and develop their own R&D departments and to raise enterprise S&T levels.

There is an additional major problem, that of industrializing China's high technology. Comrade Deng Xiaoping recently issued an explicit call to "develop high technology and carry out its industrialization," and we believe that this is correct. There are several problems in China's industry structure that urgently require readjustment, but the development of China's high-technology industries brooks no delay because of its importance in elevating high-technology industries in China's industrial structure. World economic development trends indicate that high-technology industries spearheaded by information technology, materials technology, biotechnology and certain other areas of high technology are the industries that are developing most rapidly and that have the greatest vitality. Their development has already had a major influence on world economic structure and on society. China embarked on these areas rather late, and we must be aware of the urgency and seriousness of the problem. In 1984, in company with the relevant departments and commissions and local leadership bodies, the CAS began to strengthen technology transfer, the purchase of technology stocks, joint operations, and direct operation of high-technology enterprises in the fields of information technology, materials technology, biotechnology, and certain other high-technology fields; the objective was to advance some high-technology personnel into the market, to find a multilevel, enterprise-connected form, and to accelerate the conversion of S&T results under market competition. As a result of several years' effort, we have made some progress: for example, the membrane technology developed by the Dalian Chemical Institute is already playing a role in the technological modernization of fertilizer plants and glass works. The model 386 and 486 microcomputer motherboards produced by the Lianxiang group are already entering international markets. We hope that all departments and large enterprises throughout the country will have the perceptivity to recognize and support these new products that promote the coordination of S&T with production and that they will jointly make a contribution to opening up and developing China's high-technology industries.

Finally, on behalf of the CAS, I thank the leadership of all departments, the representatives of all enterprises and S&T organizations and the comrades of the theoretical

sphere and the journalistic world; it is to be hoped that everyone will contribute his experience, knowledge and insight, that a consensus will be reached, and that everyone will move forward in concert, breaking new paths in using science and technology to promote enterprise development, in order to make a contribution to China's economic progress.

Liu Huaqing on Promoting National Defense, Military Modernization

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Interview with Vice Chairman of Central Military Commission Liu Huaqing by Lin Yushu [2651 3768 2885], Liu Yuren [0491 5280 0117], and Zheng Wenyi [6774 2429 5669]: "Rely on Scientific and Technical Progress to Promote Defense Construction"]

[Text] Gradually moving defense and army development into a reliance on scientific and technical progress and on improvement of worker skills is a fundamental guarantee of the advancement of China's defense and military modernization and of the strengthening of the military's combat capabilities. In order to give fuller expression to our army's major achievements in 40 years of reliance on scientific and technical progress, on 13 March, reporters Lin Yushu, Liu Yuren and Zheng Wenyi of this newspaper visited Comrade Liu Huaqing, Vice-Chairman of the Central Military Commission and requested that he give his views on the importance of developing science and technology for national defense and on how to improve the standards of defense science and technology and to nourish and train a highly skilled defense S&T contingent. The full text of Comrade Liu Huaqing's remarks is printed below.

I. The idea put forward by Comrade Deng Xiaoping that science and technology constitute the first productive force is of important guiding significance for defense and military development.

Science and technology are the most vigorous factor in production capabilities and the most important driving force. Especially in the last few decades, there has been a worldwide scientific and technical revolution which has profoundly influenced the historical progress of human society. With the farsightedness of a great strategist, Comrade Deng Xiaoping devoted major concern to the current progress in scientific and technological development. He has frequently emphasized the major importance of science and technology for China's socialist modernization. As early as 1975, while leading the rectification of science and technology activities, he fully affirmed, in refutation of the falsehoods of the Gang of Four, that science and technology are productive forces. In 1978, at the national science and technology conference, he clearly enunciated the Marxist view that science and technology are productive forces and put forward the guiding idea that the key to implementing the four modernizations is scientific and technical modernization. In 1988, based on a profound analysis of the developmental trends of socialism, he further stated that science and technology are productive capabilities and are in fact the first productive capabilities. Recently, he again emphasized that for economic development to accelerate, it must rely on science and technology and on education; our only hope is to emphasize science and to rely on science. These major pronouncements by Comrade Deng Xiaoping, stated with increasing clarity and increasing emphasis, thoroughly embody the sense of historical responsibility of the older generation of proletarian revolutionaries and the great hopes that they place in the cause of China's science and technology. These major declarations have enriched and developed Marxist theory of science, technology, and productive capabilities, and have revealed the immense revolutionary effect of science and technology on current economic development and social development. They are a major advance in Marxist theory and not only have great and profound guiding significance in China's socialist economic construction, but also lay a firm ideological and theoretical foundation for correctly understanding the role and function of science and technology in defense and military development and for defining China's defense development strategy and guidelines.

II. To carry out defense and military modernization, we must accord full importance to science and technology and implement the guideline of focusing on quality development.

The great effect of science and technology can be thoroughly manifested in the military sphere. All through human history, science and technology have achieved major breakthroughs, and almost without exception they have first been employed in military affairs. Weapons and equipment, strategy and tactics, organizational systems and the like are dependent on the level of productive capacities of the time. The present-day development of science and technology is having an increasingly great effect on defense and military development, and we are entirely justified in saying that they are combat force multipliers. As a consequence, many countries are competing in drafting science and technology plans and are striving to seize the current commanding heights and advanced positions of science and technology in order to obtain future strategic and military superiority. In this major battle of science and technology, in which no shot is fired, any country or army may be attacked or adversely influenced, and whoever falls behind may be controlled by others and fall into a passive position. In the 40 years since the state was founded, our defense development has posted achievements that have attracted world attention, and to a great extent they have been based on an arduous struggle for scientific and technical progress. The party Central Committee, the State Council and the Central Military Commission have consistently attached full importance to national defense science and technology, and by dint of decades of struggle, they have created a respectable national defense science and technology industry system, have

developed and produced large amounts of weapons and equipment, and have satisfied our army's need to develop from an exclusively land force to a combined force that includes an air force, a navy, artillery, antiaircraft and other service arms. In particular, in making technological breakthroughs, we have successfully mastered sophisticated technologies, including the "two bombs and one satellite" and nuclear submarines, and have made a contribution to maintaining world peace and national security. The experience of the last decades demonstrates that defense and military development must be centered on modernization. Without this modernization there can be no modernization of weapons and equipment and it will be impossible to assure the compact capabilities of the military. In the new historical period, as the focus of party and state work shifts to economic construction, there have also been strategic shifts in the guiding ideas of defense and military development. Under Comrade Deng Xiaoping's leadership, as a result of more than 10 years of effort, we have gradually created a well-rounded set of guidelines, policies and principles for building a modernized, standardized revolutionary army. At present our army is implementing the policy of placing the emphasis on quality development and is taking the approach of creating Chinese-style crack troops. This is the pressing requirement that the age has imposed on our army. Intensifying the army's quality development requires efforts in several areas, particularly important among which is the reliance on scientific and technological progress to improve weapons and equipment, to raise management standards, and to train personnel in all areas, in order to accelerate defense modernization. All officers and men throughout the army must conscientiously study and master Comrade Deng Xiaoping's idea that science and technology are a productive force, and must become fully aware of the prominent place and effect of science and technology in the modernization of our army. In particular, military leaders at all levels must consider this problem in strategic terms, consciously strengthen their science and technology awareness, and seek for benefits, quality and combat capabilities from science and technology. Only by conscientiously and thoroughly altering their conceptions, according the subject its full importance in their thinking, and conscientiously implementing it, can our military and defense development efforts hope to succeed.

III. Strive to raise defense S&T to a new level.

Developing defense S&T is a major guarantee for strengthening defense capabilities and overall national capabilities. The central party authorities, the State Council and the Central Military Commission have always accorded full importance to developing defense S&T. They not only have drafted a series of correct guidelines and policies, but also have made use of all possibilities during each period of national economic development to maintain funding of defense S&T, thus laying the foundations for its development.

In the last decade or more, under the impetus of reform and opening to the outside, defense S&T has developed greatly, and this has also been the period in which it has posted the greatest number of achievements. During the Seventh 5-Year Plan alone, the defense S&T front won 1003 national S&T progress awards, 190 invention awards, 21 special state awards, and two national science awards. But we must also be aware that in certain aspects of defense S&T we are still considerably behind the world state of the art. In order to narrow this gap as rapidly as possible and to accelerate defense modernization, during the Eighth 5-Year Plan, in addition to continuing to main defense S&T investments consistent with national capabilities, we must focus on the following problems.

First, we must make reform more thorough, expand our opening to the outside, and establish and perfect new types of defense S&T systems. The defense S&T front must continue to deal effectively with the strategic shift and conscientiously implement the policy of "integrating military and civilian production, integrating peacetime and wartime arrangements, according priority to military goods and using civilian production to nourish military production." While assuring that the military's needs are met, the defense industry must orient itself to the main battlefield of economic development, vigorously pursue the transfer of military technology to civilian technology, and gradually form a high-technology industry cluster that integrates civilian and military production, production for domestic uses and export, and technology, industry and commerce. We must devote attention to absorbing advanced civilian technology, developing dual-use military and civilian technology, further perfect the development model of embedding military production in civilian production, and promote the development of defense S&T.

We must search for ways and means of integrating plan management and market adjustment within defense research and production. Military goods are special commodities, and the process of their development and production has its own distinctive laws. As a consequence, the levers of plan management and market adjustment must both be used effectively. On the one hand, in macroscopic management and in key areas, we must emphasize the necessary directive plans and assure that they retain their authority and scientific character; on the other hand, in the enterprises and research units we must introduce the competition mechanism, further promote and perfect the contracting system and motivate all parties. We must take advantage of the current favorable moment to actively bring in advanced foreign technology. If we wish to place ourselves in an unassailable position, the best way is self-reliant reconstruction. But we must also bear in mind that now, when science and technology have become internationalized, shutting ourselves off is not acceptable. We must be somewhat bolder, open the door a bit wider, vigorously absorb advanced foreign technology and management techniques, and integrate importation, absorption, and innovation, in order to raise the level of our defense S&T.

Second, we must strengthen centralized, unified leadership and vigorously engage in coordinated joint breakthrough projects. National defense S&T directly affects the improvement of national security and of overall national capabilities, and we must therefore continue centralized and unified leadership. This is an important guarantee of continued, stable, coordinated progress in defense. In the 1950's and 1960's, when China's industrial and S&T base was extremely weak, one of the most important ways that S&T was able to post major achievements was that we made full use of centralized and unified leadership. Now, when our defense S&T development is in a key period, we have a special need for correct handling of the relationship between centralization and decentralization. In terms of macroscopic policy making and management, we need a unified program, unified command, and unified implementation, and we must overcome undesirable tendencies toward decentralization. At the same time, we must make policy making more scientific and democratic, vigorously improve the science policy-making system, gradually implement management techniques that unify programs, plans, and forecasts, and strictly follow the policy-making practices and laws of scientific research.

The development of defense S&T influences an extremely wide area and constitutes an immense system-engineering project. It is not only the responsibility of the military and the defense S&T departments, but also is a joint responsibility of the other fronts. Particularly since we have entered the age of high technology, the development of defense S&T has become highly difficult and highly interconnected. As a consequence, we must make thorough use of the socialist system's advantage of being able to concentrate resources for major undertakings, engage in coordinated national-scale planning, mobilize and direct all relevant forces, and engage in a coordinated struggle to overcome scientific and technical bottlenecks.

Third, we must make the development of high technology a strategic focus and strive for breakthroughs in key technologies. In today's world, high S&T is developing rapidly and competition is unprecedentedly fierce. A major technological breakthrough not only can spearhead the development of a group of industries, but can induce major changes in combat techniques and in the military sphere. The challenge and opportunities are both present, and we must become profoundly aware of the role and effect of high S&T in current military affairs. We must consistently make the development of high S&T our focus and take our rightful place in the world S&T arena.

To develop high S&T and to use new technology to develop new weapons, we must expend large amounts of funds. In the current situation of insufficient funding, if we wish to carry on several major undertakings, we must shorten our battle lines, break through at the key points, and concentrate our forces for a fight to the death. We must continually track the directions of development of world high S&T and accord full importance to investigating new ideas, new principles, new concepts and new methods, and at the same time we must strengthen advance research on certain key technologies.

IV. Respect knowledge, respect ability, strive to improve the proficiency of all military personnel, nourish and train a highly capable defense S&T contingent.

The development of our military has entered upon a new period, and in order to adapt to the needs of modern combat, we must attach the proper importance to scientific and cultural knowledge and to raising the qualities of all officers and men. When we refer to qualities, we mean not only a high level of political awareness and devotion, but also the possession of scientific and cultural knowledge and the grasp of modern military skills. Modern weapons and equipment can be mastered only by people with modern scientific knowledge. The development and modernization of the army requires people with awareness, knowledge and abilities. In the absence of a large contingent of people with an understanding of science, defense modernization is an empty phrase. As a consequence, a favorable spirit of respect for knowledge and ability must be established in the military. We must vigorously carry on political, scientific and cultural education and raise the ideological and cultural level of all personnel. We must put a major effort into running effective military educational institutions of all kinds, train highly skilled commanders and a technological cadre with high technical proficiency. We must continue to carry on personnel training with both military and civilian uses, so that after demobilization or transfer to civilian work they can give their skills full play in national economic construction.

The competition in science and technology is in essence a competition in human abilities. Defense S&T is a knowledge-intensive and technology-intensive area, and it has an even greater need for a large red-and-expert nucleus of qualified personnel; in particular, it needs scientists and engineering and technical personnel who are first class by world standards. For several decades, we have trained a defense S&T contingent on a large scale, and this is a basic guarantee of progress in defense S&T. In the future, we must energetically spread the good tradition of "arduous struggle and selfless devotion," and further raise the ideological and professional qualities of S&T personnel, improve their working and living conditions, accord full importance to utilizing them, and mobilize their activism, initiative and creativity. Major rewards should be given to scientific and technical personnel who make outstanding contributions. Creating an environment for young S&T personnel that encourages the emergence of talent will assure a continued supply of manpower for defense S&T.

The reliance on scientific and technological progress for defense modernization is a special mission that history has entrusted to us, and requires not only that the military and defense S&T workers make unflagging efforts, but also that it be supported by everyone in the

country. Unless scientific and technical standards are improved countrywide and unless the people of the entire country and all scientific and technical workers participate, there will be no progress in defense and in military development. Further strengthening the defense awareness of the entire people and creating a good environment of concern for and support of military development and defense S&T is the only way to assure that our defense modernization effort will be able to advance rapidly.

Significance and Economic Benefits of Developing a Modern Cruise Missile for China

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[Excerpts from article by Xu Ande [1776 1344 1795] of the Shanghai Aerospace Bureau: "The Strategic Significance and Economic Benefits of Developing a Modern Cruise Missile for China"]

[Excerpts] The Gulf War has greatly increased our sense of crisis and sense of urgency regarding reinforcement of national defense construction, and it has left our national defense with many contradictory ideas. To resist possible future threats and challenges and to establish an invincible position in future wars, one urgent task is for us to do more work, and one thing is: we must quickly develop China's cruise missiles! [passage omitted]

II. The Strategic Significance of Developing a New Generation of Cruise Missiles for China

The Gulf War allows us to project clearly that the depth of future wars will be greater depth and further depth, even full depth. Developing modern cruise missiles, a long-range guided weapon, is very valuable for improving a country's overall fighting strength. With "long range", one can fire before the enemy, fire out when encircled by enemy forces, and gain control of the battlefield. If we do not have a powerful air advantage and also do not have effective long-range offensive measures, when we are attacked, how can we counterattack to deter and shock the enemy from outside the enemy's defense area?! Moreover, to ensure China's sovereignty, carry out marine development, and protect marine trade routes, the navy may have to conduct a defensive war in great depth and at many levels on the seas. Without cruise missiles, how can we establish national defense forces that cover our entire marine area?!

The Gulf War has shown us clearly that on the Iraqi battlefield, not only was the equipment on the first line of the ground war armored, but also the radar, the communications, command and control centers, and many electronic and optical systems in deep areas had also been reinforced and "hardened", with personnel hidden in fortifications and extremely well protected. Undoubtedly, future objectives will certainly be further "hardened" and often only direct hits can destroy them. Future wars will rely to an even greater extent on cruise missiles and other precision-guided weapons.

The launch modes of modern cruise missiles are flexible, especially when they are launched from submarines, where they are even more difficult to detect and discover. In future wars, whoever has cruise missiles will often also have the capability of carrying out a second nuclear attack. This will have a major impact on the outcome of future wars.

Now, growing numbers of countries in succession are making cruise missiles a new generation of advanced precision-guided weapons for inclusion in their equipment. Even Japan, India, and other countries surrounding China are now developing cruise missiles. This without doubt is because modern cruise missiles are an effective deterrent and an ideal weapon to supplement a limited nuclear deterrent. Modern cruise missiles, an assemblage of high and new technology of the modern era, have become an important indicator of the strength or weakness of a country's national defense forces and a concentrated embodiment of a country's comprehensive S&T capabilities. China is now focusing on economic construction, but economic construction can be guaranteed only by being backed up by a powerful national defense backup force. Without this backup force, we will be vulnerable to attack and be controlled by others, and the results of economic construction will be destroyed in a moment!

To strengthen China's future ability to counterattack and attack in local wars and peripheral wars, and to increase the strengths of China's military to contend with our enemies, we must develop as quickly as possible China's new generation of cruise missiles. To increase our military prowess and national might, and to create a peaceful environment for China's people to develop economic construction, we must have a deterrent force that is dominated by a new generation of cruise missiles and other precision-guided weapons!

III. The Economic Benefits of Developing a New Generation of Cruise Missiles for China

Developing modern cruise missiles not only has extremely important strategic significance and tactical value; it also has rather good economic benefits. Emphasizing this point is particularly necessary for China, which does not have sufficient economic strengths at present. History tells us that the economic benefits of a successful type of weapon are often the basic factor or ultimate factor that determines whether or not it has development value and a development scale.

How can the economic benefits of a type of weapon be measured? I feel that first, we should look at the economy that arises from the design continuity, interchangeability, and systemization of this type of weapon as well as rational organizational management. Second, we must look at the economic burden that application of this type of weapon will create for the enemy. We must

study the cost that the enemy must pay to defend against attack by this type of weapon and the ratio of this to the expenditure we must make to develop and utilize this type of weapon. The greater this type of "benefit-cost ratio" or "exchange ratio", the better the economic benefits.

The development of cruise missiles in the United States embodied first of all the excellent continuity of modern cruise missiles. The United States' cruise missile ALCM was developed on the basis of a "subsonic armed missile decoy". Most research achievements for the latter were applied in the former and abundant experience was accumulated regarding small, high-performance turbofan engines to improve cruise missiles and the structure of cruise missiles. The continuity of ALCM-carried equipment and ground equipment was even higher. Information revealed by the Boeing Corporation shows that 92.4 percent of its launcher and computer program equipment were identical to the equipment that corresponded to the short-range offensive missiles originally carried by the B-52. At that time, this item alone saved $218 million. The "Tomahawk" SLCM involved even greater continuity of the achievements of the "Harpoon" (Harpoon RGM-84A) naval antiship missile, and its inertial guidance system was also improved on the basis of the "Harpoon".

Second, the "Tomahawk" SLCM and ALCM also embodied the excellent interchangeability of modern cruise missiles. Many of the components in each of these two are interchangeable, such as the inertial guidance system in the control system, terrain-matching and optical-digital scene matching devices, as well as the warheads (W-80 or W-84), engines (F107-WR-100), and so on.

Moreover, the degree of systemization of modern cruise missiles is also very high, the "Tomahawk" cruise missile being a prominent example of this aspect. According to data I saw recently, the "Tomahawk" series cruise missile has now undergone over 10 modifications: for example, BGM-109A, B, C, D, E, G; AGM- 109I, J, K, H, L and so on. The "Tomahawk" shows us that modern cruise missiles not only have strategic and tactical applications, but also can derive many uses from a single missile. This is related to the assembly-type structure of modern cruise missiles. Each assembly is produced for different purposes in various modular sections of identical diameter, making design modifications extremely easy and enabling substantial reductions in cost.

The excellent continuity, interchangeability, and systemization of modern cruise missiles have enabled the United States to achieve success at relatively small cost and produced extremely significant economic benefits.

To conduct intensive research on the economic benefits of modern cruise missiles, we must also study the cost that the enemy must pay to defend against attack by cruise missiles.

The deployment of cruise missiles by the United States caused the former Soviet Union to feel an extreme threat and as a result it had to assume an extremely heavy burden of defense expenditures. Calculations by the United States Department of Defense in 1978 showed that if the United States deployed 3,000 cruise missiles for the purpose of a saturation offensive against the former Soviet Union, the former Soviet Union would be forced to deploy a set of new defensive systems that would include:

1. Equipping 50 to 100 long-range warning and control aircraft similar to the E-3A (AWACS);

2. Equipping 1,000 high-performance interceptors similar to the F-14 and F-15 grades with the capability of searching for and shooting down cruise missiles;

3. Having to build 500 to 1,000 air defense missile bases equivalent to the SA-10 that are capable of rapidly responding to and intercepting cruise missiles and capable of effectively destroying B-52s or other carriers with air-launched cruise missiles.

It would take 7 years to complete all of these systems at a total cost of $90 billion.

However, we can calculate from the data listed in the preceding table that the United States spent $8,358,100,000 to outfit 300 ALCM cruise missiles. Adding the cost required to convert 170 B-52 bombers as carriers, calculations by the United States Department of Defense indicate that the total cost would be about $10 billion.

Thus, the "exchange ratio" or "benefit-cost ratio" between defending against cruise missiles and deploying cruise missiles is 9:1.

In closing, we should also note that for a particular country, the indirect economic benefits from redevelopment of missile technology or emerging industries that arise from missile technology are even broader. Modern cruise missiles concentrate many high and new technologies like inertial guidance, terrain matching, scene matching, terrain tracking and evasion, regionally interrelated terminal guidance technology, small turbojet and turbofan engines, supercritical bomb wings, jamming and counter-jamming, concealment and counter-concealment, and so on. Development of a new generation of cruise missiles will undoubtedly promote the development of these advanced technologies in China and actively give impetus to several related industries. The transplantation, extension, and conversion from military to civilian uses of missile technology from China's space system over the past several years have made extremely important contributions to the growth of China's national economy and created several billion yuan in economic benefits and uncountable social benefits. We are entirely right in believing that high and new-tech from a new generation of cruise missiles will play an even greater role in promoting growth of China's national economy!

For this reason, after debate on many areas, it is entirely proper for us to believe that developing modern cruise missiles would also have substantial economic benefits.

Cruise missile technology is also a technology for which China has a technical foundation. Since the 1950's, our development of winged missiles and early cruise missiles has provided us with comprehensive and abundant design experience and technical foundations for developing our own new generation of cruise missiles. Missile weapons systems are a synthesis of modern technology. A successful model lies in the ingenious continuation of existing technical achievements and utilizing reliable components that have been tested as well as the adoption of the newest technology in key components to improve the tactical and technical performance of the system. We have already taken a route in developing missile weapons systems that conforms to China's national conditions and we have relied on our own forces under arduous circumstances and have now formed a complete and matching development and production system that produces multiple series and multiple models of winged missiles that have advanced technology, high precision, and great power. Simply by continuing to follow our own path and taking aim at even more advanced indices, reinforcing attacks on key technical problems, and fostering all of China's S&T advantages in a major effort at coordination, absorbing advanced technology and management experiences from foreign countries as appropriate, it is both extremely necessary as well as entirely feasible for China to develop a new generation of cruise missiles.

Developing Chinese cruise missiles can first involve developing a new generation of tactical cruise missiles. Because of the strategic and tactical compatibility of cruise missiles, achieving a tactical model can also play a role as a strategic deterrent. When we have a tactical model, we can then develop a strategic model. This conforms even more to the realities of China's technological development. Moreover, cruise missiles are the weapon in highest demand in the international military trade market at present, so developing a new generation of cruise missiles would not only reinforce our own national strength requirements but would also satisfy demand in the international military trade market. This would benefit the military as well as the country by killing several birds with one stone.

Discussion of Strategic Shifts in National Defense Industry

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[Article by Xiang Nianxing [0686 1819 5281], Liang Wenjun [2733 2429 6511], and Zhang Jianshu [1728 1696 2885] Office of National Defense S&T Industry Committee: "Strategic Shifts in the Defense S&T Industry"]

[Text] The national defense science and technology industry is currently at a key state of the strategic shift, and the problems of the relationship between civilian and military production, between peacetime and wartime arrangements, and between long-term and current orientations urgently require resolution in the course of the reform and development of the industry. Correctly recognizing and handling these problems, with their macroscopic significance, is of great importance for smooth implementation of the strategic shifts in the national defense S&T industry and for its stable and coordinated progress.

1. Deal Effectively With the Relationship Between Military and Civilian Production at the National, Department, and Enterprise Levels, and Move the Military Industry Into a True Beneficial Cycle of Development

The main subject matter of the strategic shift in the national defense S&T industry is the requirement to make it into an industry that combines military and civilian production. To deal correctly with the relationship between military and civilian production, we must follow the principle of "priority to military products and use of civilian products to nourish military production," implement "coordinated planning of both civilian and military production," and integrate military and civilian production at the national, department or industry, and enterprise levels.

—At the national level, the key is to implement overall planning and macroscopic control, to make the national defense S&T industry an important component of the national economy, and to give comprehensive consideration to the national defense S&T industry's productive capabilities, industry structure, disposition and coordination, and wartime mobilization provisions. The civilian goods production and technology-development orientation of the national defense S&T industry should be subject to macroscopic guidance by the comprehensive state departments, with implementation of the principle of "equal treatment, equal preference, and appropriate consideration," incorporating it into the development programs of all industries and implementing the "use of civilian goods to nourish military production." At present, owing to awareness problems, the state's program and plans for the use of military technology and capabilities in its comprehensive planning of the development of civilian products has not been completely implemented. Other than civilian aircraft, ships, satellites and nuclear power, the civilian products in all of the major areas come under the cognizance of the civilian-goods production departments, and tasks and resources are for the most part being distributed to the cognizant departments of the respective industries without thorough consideration of the needs of the military industry itself. The overall superior situation of the military S&T industry, and especially its scientific and technical superiority, has not been thoroughly utilized. Even more important than

breaking down the lines that divide the industries and helping military industrial enterprises to fit themselves into the program is a priority effort to arrange the retooling of production by military industrial enterprises so that they can participate in newly established projects.

—At the department or industry level, we must concentrate on adhering to the principle of "priority to military goods." Military goods are the basis of the defense S&T industry; civilian goods are the means by which the industry can become wealthy. If the development and production of military goods is put on the same level as that of civilian goods or is actually relegated to a lower position, then the basis of the military S&T industry will wither. In addition, in response to the changing tasks of each of the military industries and in accordance with state industrial policy, we must engage in comprehensive planning and program development aimed at the readjustment of research and production capabilities and at the orientation of technological development, and we must vigorously develop saleable products. In recent years, because certain departments have been excessively concerned with "nourishing enterprises" in the civilian-goods production locations, they have somewhat neglected questions of industry structure and have been lacking in benefits-mindedness, and some departments have actually given their main support to products that are outside the state production policy and have made products that are not state-designated into the key focus of new construction or expansion; this is a tendency that must be rectified in the future development of civilian products. Third, we must adapt to the system and operating mechanisms of a planned commodity economy. Military goods come under the state directive plan, and in the course of readjusting the product mix, there must be separate lines for military and civilian production. In addition to products subject to the state directive plan and to guidance plans, the products converted from military to civilian use also include a large number of products subject to market regulation, and these must be accorded their full importance.

—At the enterprise level, we must first act in accordance with the military production assignments and find organizational forms for establishing combined military and civilian enterprises; we must engage in comprehensive planning for in-house civilian and military production assignments, for the management and utilization of manpower, financial resources and material resources, and for earnings, bonuses, distribution and the like. Second, in accordance with state industry policy and market requirements, we must continuously adjust the product structure so that it has strong viability. The military-industry enterprises should not unreflectively seek the role of overall manufacturing plants, but must act in accordance with real enterprise conditions in deciding on their product lines. Third, and most important, we must rely on scientific and technical progress to adjust structure, to increase benefits, and to raise output value rather than relying on funds accumulation. Currently, the loans that enterprises are seeking to obtain are on the short-term funds market, and they primarily meet cash flow requirements after the product structure has been set rather than solving problems that arise from an irrational product structure. To a certain extent, this short-term funding behavior has protected the continuation and development of an irrational industry structure; people should gain a sober awareness of this point.

2. The Development of the Defense S&T Industry Should Not Avoid Addressing the Conflict Between Peacetime and Wartime Production: The Chief Means of Resolving This Conflict Is To Readjust Structure and To Integrate Military and Civilian Production.

In general terms, the relationship between peacetime and wartime production arrangements is that the two must be coordinated. So long as the danger of war exists, even in the peacetime period of construction no country can neglect the requirement of preparing for war. Since the Third Plenary Session of the 11th Central Committee, the focus of the party's work has shifted to economic construction, but defense modernization is still one of the main tasks of socialist construction in peacetime. This indicates that in terms of macroscopic policy, the state has already given consideration to the relationship between peacetime and wartime and as a consequence has presented the defense S&T industry with specific tasks regarding the coordination of peacetime and wartime production.

At present, four contradictions that have expressed themselves in the implementation of the strategic shift in the defense S&T industry require our close consideration.

A. The contradiction that productive capacities are excessive in peacetime and insufficient in wartime. During peacetime, if productive capacities are cut back to a minimum, military production tasks are not satisfied but productive capacities are excessively great; in wartime, even if a general mobilization is carried out, capacities are markedly insufficient. There is a gap between these two situations.

B. The contradiction that in peacetime the focus is on research, and in wartime there is an urgent emphasis on production. Peacetime provides a good opportunity for developing defense S&T, for "more research and less production," and for laying foundations and raising our level so as to basically eliminate our behindhandedness in weapons and military equipment and to narrow the gap with other countries; this is a well known fact. But the step from finalization of plans and finalization of production models to the equipping of the troops is a rather long one, and what is important in wartime is not research but production. Whatever armaments are produced are the ones that the troops will get, and whatever weapons the troops get are what they will use in battle. In other words, the focuses in peacetime and wartime are different.

C. The contraduction that in peacetime there is a reserve of productive capacity, while in wartime there is large-scale production. At present, military orders are using only a third of productive capacity, and many of the other production lines have had no tasks for a long time. But protection and maintenance funds are insufficient, so that some production lines will be hard to put back into operation: if large-scale production were needed in wartime, these reserve capacities would not immediately be able to meet requirements.

D. The contradiction that in peacetime the military industry's integrated equipment production system is incomplete, and in wartime, mobilization capacities are insufficient. On the one hand, under the influence of the commodity economy, military production tasks decrease, and the directive plan for military products is impacted. Thus the system that originally supported integrated military industry production tasks is thrown into disorder, the meeting of military product quality requirements and delivery deadlines cannot be guaranteed, and military production capabilities that have been placed in reserve with state permission actually cannot be turned into a system of integrated production capacities. On the other hand, the relevant units are not yet taking a comprehensive enough view of what the integrated production enterprises will produce during wartime, of the size of their output and their production deadlines, or of the enterprises to be coordinated with them, the materials needed, and the sources of materials and needed equipment. Thus it is clear that during wartime it will be difficult for these enterprises to spin up rapidly to the manufacture of integrated sets of products needed by the military, and this fact might result in inadequate capabilities in the event of a wartime mobilization.

There are two approaches to resolving the above contradictions. The first is to increase investments; but current national conditions prevent us from investing large sums to maintain peacetime production capabilities at wartime levels. The second is a structural readjustment; this constitutes the main approach, which we have been energetically studying for many years. Based on the above insights, the basic principle for dealing with the peacetime and wartime aspects of the national defense S&T industry during peacetime is to readjust military-industry production capabilities in accordance with needs and to convert the excess production capacities, with state assistance, to the production of civilian goods. The objective of post-readjustment military industrial capacities is the establishment a defense S&T industry system consisting of a "small military industry with large mobilization capabilities," in which military and civilian concerns are coordinated. The term "small military industry" means that it is a fully rounded military industry on a small scale, with a full complement of product varieties, that maintains a reserve set of production lines for military products. "Large mobilization" means a military industry mobilization system on a scale greater than the ordinary military industry. This mobilization system differs somewhat from the traditional use of the term by being divided into two levels: the first level is military plants with "sealed-up" capacities, including directly subordinate enterprises, local military plants and mobilization plants; the second level includes enterprises that have been included in the military industry mobilization plan and the advance mobilization program, including directly subordinate enterprises whose military production capabilities have been canceled and which have been converted to civilian production, local military-industry plants and mobilization plants, and civilian enterprises subject to wartime mobilization. After this readjustment, the military industry enterprises will be divided into two classes. The first will be the standing military industry, and the second will be the mobilization military industry. Depending on the nature and tasks of the enterprises, these two categories will be subject to separate guidelines in the implementation of the policy of "guaranteeing, nourishing and readjusting."

3. Focus on the Long Term, Coordinate Long-Term and Short-Term Orientations, Correctly Handle the Relationship Between Long-Term and Current Arrangements, and Develop a Chinese-Style Defense S&T Industry

The development of China's national defense S&T industry must focus on the long term but coordinate long-term and short-term orientations. This requires that we correctly handle the following three problems.

—National defense enterprises give emphasis to advance research and to the development of new models of weapons and equipment. Advance research is the principal means of increasing the reserve potential for military development, and the development of weapons and equipment is the principal means of increasing in-place military capabilities. To focus on the long term, we must make advance research a strategic measure for thoroughly eliminating our backwardness in military weapons and equipment and for narrowing the gap between China and the world state of the art. We must redouble our efforts and must thoroughly overcome the earlier tendencies toward duplication in the development of weapons and equipment and toward an insufficient emphasis on advance development. But from another viewpoint, the strength of our national defense capabilities is based on in-place capabilities, and if our reserve technological capabilities cannot be quickly converted to in-place capabilities, the development of defense S&T will be meaningless. We must adopt an attitude of having advance research both guide and serve the development of weapons and equipment. Advance research must focus on technologies that are advanced according to world standards, and that enable us to take rapid strides in raising our defense S&T level and maintaining the momentum of China's defense S&T development; at the same time, we must provide for a technological reserve for the development of the next

generation of weapons that will allow a smooth changeover from technological reserve status to in-place capabilities.

—Develop new-generation weapons systems and modernize existing weapons and equipment. The future strengthening of China's military capabilities will be thoroughly manifested in the sophistication of the next generation of weapons systems. If the next-generation weapons systems that we are developing do not effectively meet military needs and cannot be fully utilized in a future war, we should not develop them. We should proceed in terms of the needs of the warfare of the future, and make effective, focused arrangements for the development of new weapons and equipment based on a rather high technological standard in order to deal with the long-term main threat. In view of the current relatively backward state of China's military equipment and the fact that the development cycle of new-generation weapons systems is rather long and that the cost of equipping the armed forces is rather high, we must also give thought to using mature high technology and new technology to modernize existing assets so as to meet the urgent short-term needs of the forces.

—Research tasks and means. The effectiveness with which research tasks are carried out directly impacts the upgrading of military assets, and research facilities directly influence the carrying out of research tasks. As a consequence, research facilities are a major factor in raising the level of defense S&T and in strengthening our staying power for development. At present, many of China's defense S&T industry facilities were built in the 1960's and 1970's, and a long time has passed without their being effectively modernized. The facilities are aging badly and the technological capabilities becoming outmoded. This circumstance is already ill-suited to the needs of current defense research and the development of weapons and equipment, and there can be no further delay in modernization. We should do away with the long-standing attitude of stressing research tasks but slighting the construction of facilities; we should focus on the long term, treat the construction of facilities as an important step in strengthening our reserve potential for the development of defense S&T, integrate the construction of facilities with research tasks, and resolve to make a major effort to create, modernize and upgrade research facilities in upport of long-range national defense research and weapons and equipment development.

Weapons Industry to Accelerate Management Changes

92FE0434C Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 10 Mar 92 p 1

[Article by Ji Hongguang [1323 3163 0342]: "Armaments Industry Will Accelerate Changeover of Industry Management Mechanism"]

[Text] It was learned from the General Office of the China Armaments Industry that although a large decline in orders for the production of military goods had created serious difficulties for the armaments industry production facilities, last year the industry began to experience a simultaneous increase in earnings and in total output value. This year the general office aims to further accelerate the pace of reform and opening to the outside and the changeover of the enterprise management system to give the enterprises increased vigor on the markets.

An official of the general office stated that this year the reform of the enterprise management system in the armaments industry involves both the overall situation and labor allotments, the implementation of optimized labor organization and the all-employees labor contract system, and trial implementation of the job-proficiency wage system as the main type of basic wage system. In addition, the enterprises will be able to make their own decisions on the hiring of personnel in the light of their actual circumstances. Directive plan management will be used in the production of military goods, but in the production of civilian goods, market requirements will be allowed to guide the product mix, and autonomous management and enterprise profit-and-loss autonomy will be promoted. There will be an appropriate decrease in the number of small accounting units, and separate production of military and civilian goods and separate accounting will be practiced. In the course of improving the contract management responsibility system, the enterprises will be required to contract for profits or losses, with strictly applied rewards and penalties.

To solve the problem of inadequate market awareness in armaments industry enterprises, the general office decided to step up the establishment of specialized marketing companies within the industry and to encourage the enterprises to strengthen their own marketing groups, assigning between 1 and 5 percent of all enterprise personnel to marketing in order to meet the need for a rapid increase in the output of civilian products.

In the course of reforming armaments-industry enterprise management, the general corporation is laying particular emphasis on the leading role of science and technology. The armaments industry's technical superiority in such fields as thermal imaging, lasers, and low-light-level technology will be used to accelerate the industrialization of high technology. Some of the technical project funds for civilian products used to support the development of key products so that the armaments industry's tradition of emphasizing quality across the board from design to engineering will be continued and will manifest itself in the production of civilian goods.

China to Exploit Deep-Sea Mineral Resources of Pacific Ocean

92FE0434I Shanghai WEN HUI BAO in Chinese 18 Mar 92 p 3

[Article by Zhang Ziqiang [1728 5261 730]: "China Obtains Permission to Develop Deep-Sea Mineral Resources of Pacific Ocean"]

[Text] China has now secured permission to develop polymetal nodules in the deep-sea region of the Pacific Ocean. Yesterday, Professor Zhu Jimao [2612 4949 2021], Director of Shanghai Jiaotong University's Underwater Engineering Institute, submitted a program for a remote-controlled observation system designed to operate at sea depths of 6000 m to the China Oceanic Association, which is the organization responsible for the development of ocean polymetal nodules. The purpose of the project is to gain a clear understanding of the geology, morphology and hydrology of the sea floor and to select sites at which mineral deposits of satisfactory quality occur.

Extremely rich polymetal nodules (manganese nodules) are produced by sedimentation on the ocean floor. They contain several dozen elements, including abundant amounts of copper, nickel, cobalt and manganese, and they are of great economic value. There are about 2 to 3 trillion tons of polymetal nodules on the floor of the oceans, and 1.7 trillion tons on the floor of the Pacific Ocean alone. Scientists forecast that continental resources of copper, nickel, cobalt and molybdenum will be nearing exhaustion in 50 to 60 years, and man will have to turn to the development of sea-floor mineral resources. The technologically developed western countries began surveying ocean mineral resources in the 1950's. In order to protect China's legitimate rights and interests in international sea-floor resource development activities, establishing a claim to and developing polymetal nodule resources has already been made one of China's mineral resource strategies. During the Seventh 5-Year Plan, China carried out surveys over 2 million square kilometers of the floor of the Pacific Ocean, and marked out about 301,000 square kilometers of prospective mineral areas in region C-C in the Pacific, bounded by 7-13° N and 137-157° W. In August 1990, China submitted an application to the United Nations Sea Bed Administration and the International Law of the Sea Administration; it received authorization on 5 March of last year. The China Oceanologic Association is now the fifth vanguard investor, after organizations in India, France, the Soviet Union and Japan, to have registered for deep-sea mining.

In order to eliminate China's backwardness in the development of Pacific Ocean polymetal nodule resources, the staff of Shanghai Jiaotong University's Underwater Engineering Institute, which developed China's first shipboard manned submersible and remote-controlled submersible, took on the heavy responsibility of proposing a program for a remote-controlled observation system designed to operate at a depth of 6000 m, based on existing technology. Professor Zhu Jimao's program is as follows. An underwater camera will be mounted on a vehicle capable of navigating freely at a sea depth of 6000 m. The vehicle will be connected to a surface ship by an electrical ship with an underwater repeater unit. Personnel abroad the surface ship will control the vehicle from a console and will use undersea images from the camera, displayed on a monitor screen, to locate mineral deposits of economic value. When the production stage begins, the device will also be usable for on-site monitoring. This system will raise China's undersea technology to a new level and will place 98 percent of world undersea resources within the reach of its development abilities.

Promoting Information Awareness of Young S&T Personnel

92FE0434A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 6 Mar 92 p 4

[Article by Li Chuanhai [2621 0278 3189], Natural Sciences Department, Dalian Library: "We Must Gradually Raise the Information Awareness of Young S&T Personnel"]

[Text] With the extremely rapid development of modern science and technology, information has become the key to promoting economic development, and it permeates every area of society. China's young scientific and technical personnel have the important historical mission of promoting the country's future scientific and technical progress, and increasing their information awareness is therefore a key matter.

We need not be modest about the fact that in the 40 years since the state was founded, and especially in the last 10 years of reform and opening to the outside, there has been a significant rise in the information awareness of young scientific and technical personnel. These young people represent a rather large percentage of China's scientific and technical force, and they make a positive contribution to the achievement of major scientific and technical results. It is reported that young specialists made up 68 percent of the specialist groups working on "863 Plan" projects alone. Not only that, but we almost daily read press reports of inspiring accomplishments and achievements by young S&T personnel based on the use of information resources. But we must also recognize that our young S&T personnel's information awareness still falls far short of the needs of scientific and technological development. Surveys have brought to light the following facts.

—When certain young S&T personnel work on a topic, they make virtually no attempt to find out what has already been done, and there is still a certain amount of confusion regarding information work and the value of information.

—Only 29 percent of S&T personnel can read a foreign language, 93 percent have never received any information training, and 26 percent have no knowledge of information retrieval.

—Nearly half of all S&T personnel have never used such valuable documents as foreign scientific and technical journals, standards, and patents.

—China's S&T personnel engaged in research projects spend an average of only 10 to 15 percent of their time collecting information, while in the US the figure is fully 59 percent.

—The rate of utilization of imported foreign-language books and publications in this country is no more than 30 percent, and in some cases it is as low as 5 percent. On average, 70 percent of publications are never consulted.

—It is reported that in the United States there is an average of 10 million computerized information searches per year, while in this country the average is only a few thousand per year.

—The rate of duplication of research in China is fully 35 percent.

The above figures make it quite clear that information awareness among China's young S&T personnel is universally weak and is far behind that in the developed foreign countries. Starting in the 1970's, the United States, Japan, and several other western countries declared that information is the focus of resource development, that information is society's "second resource," "invisible wealth," or "key to problem solving" and the most vital component of productive capabilities, and that the ability to develop and utilize information resources will effectively promote technical, economic and social development. It is reported that from 1945 to 1970, 25 percent of Japan's S&T investment was used for information and that this information brought into being 70 percent of all mainstream industrial technology. Some 32 percent of the increase in the output value of the Japanese economy in the postwar period resulted from the use of information. In the early 1980's, the US announced that more than 50 percent of its gross natural product was related to scientific and technical information. This makes clear the great importance that the industrially developed countries attach to the materialization of information and indicates their awareness of the increasingly direct connection of information with technology and the economy.

As a consequence, we must vigorously raise the information awareness of the generation of young S&T personnel who will cross over into the next century, step up our efforts to publicize science and technology and thoroughly rectify the current low level of information capabilities; these are essential steps if we are to face boldly the challenges of world scientific, technical and economic competition in the 21st Century and to take up the heavy tasks of China's scientific, technical and economic development.

First, we must strengthen the organic linkage of scientific and technical awareness with information awareness. The idea that science and technology are the first productive force has gradually entered into the consciousness of young scientific and technical personnel. But S&T information is a major component of this first productive force: it is a vanguard promoting scientific, technical and economic progress and is an inexhaustible treasure-house. To achieve universal recognition of this principle among young S&T personnel still requires vigorous and intensified publicity efforts.

Second, we must publicize more vigorously the conversion of information products to commodities and promote the development of an information industry. The output volume and output value of the information industry are a concrete expression of a modern society's information capabilities. In China, practicable, effective measures such as publicizing the development of databases and the use of computer linkages for information retrieval must be taken in order to convert information products into commodities and to promote the development of the information industry. Only in this way, through the development of the information industry and practical experience of its value and capabilities, will it be possible to make young S&T personnel truly aware of the position and function of information work and to increase their information awareness.

Third, vigorously develop efforts to publicize information and disseminate an awareness of information. This work has already become standard practice and has been systematized in the developed countries. For example, the Japanese government is constantly holding such mass publicity activities as national "information months" and "science and technology weeks." China should have similar S&T publicization activities and should use real examples and the like to publicize the capabilities, value and effectiveness of information to young S&T personnel and to the entire society in order to raise their information awareness.

Publicizing science and technology should create a climate of public opinion in which the entire society is concerned with increased information awareness and supports increased information awareness on the part of young S&T personnel. Scientific and technical publicization must help the entire society in its efforts to raise the information awareness of young S&T personnel; this is an undertaking in which a major effort should be made now.

Trends in S&T Human Resources Development During the 1990's

92FE0434F Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 23 Mar 92 p 3

[Article by Zhen Yuantai [3914 3293 3141], Chinese Personnel and Human Resources Institute: "Analysis of the Status of S&T Human Resources Development During the 1990's]

[Text] The 1990's is the key period for China's economic takeoff. As the primary resource and most important factor in production capacities, what trend of development will scientific and technical manpower resources exhibit during this historical process? In this article, we use the historical experience of the 1980's to analyze the likely trends in the 1990's.

1. If the Annual Average Rate of Increase of the 1980's Is Maintained, the S&T Manpower Pool Will Meet the Manpower Needs for Economic Takeoff in the 1990's.

The scale of S&T manpower resources has a a specific correspondence to economic growth. In the latency stage of economic takeoff, under the stimulus of the economy's acute need for S&T manpower, the number of S&T personnel expands faster than the rate of economic development, with the expectation that when the trained-personnel threshold for economic takeoff is reached, this will promote economic takeoff.

The rate of increase of S&T manpower density (i.e., the percentage of S&T personnel among a society's work force) is highly correlated with the rate of economic growth. For example, the coefficient of correlation with the rate of increase in labor productivity is 0.96 and the coefficient of correlation with per-capita output value is 0.97. Thus, the S&T manpower density is commonly regarded as an important measure of the S&T manpower pool. The threshold for economic takeoff in terms of the S&T manpower density is 7 percent.

China's S&T manpower resources increased from 9.848 million in 1980 to 23.765 million in 1989 (including personnel in units under collective ownership), and the annual rate of increase was 9.96 percent, exceeding the economic growth rate of 6 percent. The scientific manpower density increased from 2.3 percent in 1980 to 4.3 percent in 1984, still 2.7 percent short of the takeoff threshold of 7 percent.

It is forecast that by the year 2000, the maximum possible size of society's labor force (a working-age population of 781 million times a labor participation rate of 82 percent) will be 640.42 million. Thus, for the S&T manpower density to reach 7 percent before the year 2000, the S&T manpower pool must expand to 44.80 million. If the 1980's rate of increase in the S&T manpower pool (9.96 percent) is continued, then, based on the 1989 S&T manpower figure of 23.765 million, it will reach the required figure by 1998.

However, it must be noted that the rate of increase in the S&T manpower pool was highly unstable. The highest rate of increase was in 1988, when it reached 20.46 percent, with an increase of 0.55 percent in the S&T manpower density. The lowest rate was 3.76 percent in 1985, equivalent to an increase of only 0.01 percent. Clearly, an unstable rhythm of development of the S&T manpower pool is not beneficial to economic development. As a consequence, in order to make the increase in the S&T manpower a catalyst for economic takeoff, we must take effective steps to maintain a steady rate of increase in the manpower pool, e.g., a more scientific and more standardized system for appointments to specialized technology posts and student recruitment and placement in advanced and secondary specialized schools. In this way, China's S&T manpower pool will be able to meet the requirements for economic takeoff during the 1990's.

2. If we boldly select and utilize middle-aged and young specialized S&T personnel, the professional-advancement structure of the S&T manpower pool can be made more rational during the 1990's.

In the 1980's, there were major changes in the professional-advancement structure of China's S&T manpower pool. In 1980, as a result of historical factors, the professional-advancement structure of the S&T manpower pool was distorted, and the proportions of senior-level, intermediate-level and basic-level specialized S&T personnel (including personnel not yet hired) was 1:15:216. As a result of a variety of system reform efforts, by 1989 the professional-advancement structure was 1:5.7:18, close to the proportions of 1:6:14 generally regarded as a rational one for the academic world.

But because the negative factors adversely affecting the professional-advancement structure of the S&T manpower pool were not entirely eliminated, owing, for example, to the influence of old concepts such as ranking in terms of seniority and favoring seniority at the expense of accomplishment, as well as to limited quotas for appointments to senior-level specialized technical positions, middle-aged and young specialized S&T personnel had great difficulty in advancing in their fields. The result was that the total number of persons with high posts in the S&T manpower pool was low and its members were aging. In 1989, of 934,000 persons appointed to high-level specialized S&T posts, 661,000 (70.8 percent) were at least 51 years old. By the year 2000, 80 percent of the existing holders of high posts will have retired. These circumstances are not beneficial to the personnel resource structure or to the development of S&T and of the economy.

On the other hand, China has a solid supply of advanced specialized personnel. In 1989 about 2.566 million middle-aged persons (aged between 40 and 50) had already reached middle-level positions, and the total number of graduate students (including students studying abroad at public expense) that had graduated since 1980 was about 200,000. But in populous advanced S&T fields, young S&T leaders are still a rarity, and experts note that by the year 2000, as a large group of holders of high posts retires, the talent gap will become even more severe. Consequently, we must begin to take effective steps in order to break down bad habits and outmoded customs, consistently make reform more thorough, and establish a good system that causes a myriad of persons with superior abilities to emerge and makes the fullest use of everyone's abilities; in particular, we must boldly select and train young S&T leaders, so that in the late 1990's, China's S&T manpower pool will have an increasingly rational professional-advancement structure and age structure.

3. Work for major breakthroughs in the reform of the management system, and thoroughly solve the problem of inadequate placement of S&T personnel.

S&T personnel will truly produce an effect only if they are involved in social and economic activities. As a

result, rational placement of personnel has an even more direct and deep-seated influence on the economy than such relatively independent of matters as the size of the S&T manpower pool and its internal structure. If the placement problem is not effectively resolved, a larger, better-structured S&T manpower pool will not produce any benefit. China's current S&T manpower resource development and management system, with its centralized contracting and centralized management mechanism, has not yet been essentially changed for the better, and the inefficient placement of S&T personnel is still a relatively serious problem. Some manifestations of the problem are as follows.

a. Irrational Distribution of Trained Manpower Among Industries. Departments with relatively high social standing that have superior material benefits have long been popular with trained personnel, but industries with arduous working conditions, such as agriculture and allied fields (forestry, stock-raising and fisheries) and geological and mining surveying, have been unpopular. According to statistics from relevant state personnel departments, between 1980 and 1989 the total number of specialized technical personnel in state administrative bodies increased by a factor of 3.28, from 462,000 to 1.516 million, representing an average annual growth rate of 14.11 percent, which exceeded by 4.15 percentage points the annual growth rate of 9.96 percent for all S&T personnel. Conversely, agriculture and allied fields and mining surveying, which were already weak in personnel terms, had a slower rate of increase: the number of specialized technical personnel in agriculture and allied fields increased from 487,000 in 1980 to 979,000 in 1989, representing an annual growth rate of 8.07 percent, 1.89 percentage points below the overall growth rate of S&T manpower. The average growth rate in the mining surveying industry was only 5.94 percent, which was 4.02 percentage points below the overall growth rate.

b. Irrational Distribution of the Trained-Manpower Pool Over Organizational Types. Specialized technical personnel tend to be concentrated in state administrative bodies and service units, while the basic-level enterprises and units that urgently need specialized technical personnel suffer from a relative shortage. There are also rather large differences in such key qualitative measures as professional-advancement conditions and education. The enterprises' senior-position ratio (the percentage of senior jobs among all jobs) is 3.37 percent, 3.6 percentage points below the figure of 6.97 in state administrative bodies and service units; the enterprises' mid-position ratio (the percentage of mid-level jobs among all jobs) is 21.24 percent, which is 3.31 percent below the figure of 24.55 percent in state administrative bodies and service units. The fraction of specialized S&T personnel in enterprises with secondary or advanced special education is 31.8 percent, 4.5 percentage points below the figure of 36.3 percent in state administrative bodies and service units. The shortage of specialized technological talent in the enterprises is one of the factors responsible for the slow technological advancement of Chinese enterprises and the low quality of their products.

c. Irrational Geographic Distribution of the Talent Pool. For many years, the placement of scientific and technical personnel has been carried on by administrative methods. In terms of geographic distribution, the central and western areas, which are relatively backward, have received special consideration, and as a consequence, the trained-manpower ratio in these two areas is higher than that in the east, while the economic benefits that these areas produce are less than those produced by the east.

In the late 1980's, with the implementation of the "coastal economic development strategy" and the increasingly thorough implementation of the guideline of "making economic activity the central focus," there was an increase in the placement of S&T personnel in the eastern region; but the overall system changes were small, and the trained-manpower ratios for the central and western regions are higher than those for the east, while the economic benefits that they produce still remain lower than those of the east. It is, of course, necessary to develop the economies of the central and western regions and to strengthen personnel resource placement there, but the problem of how to unify personnel placement with economic benefits and to make thorough use of qualified personnel is an even more complex and daunting task. We must face these problems squarely and solve them.

In the efforts to place scientific and technical personnel, such matters as setting up and improving the market mechanism, expanded hiring autonomy for economic bodies, and increasingly scientific macroscopic regulation by the government, are key reform measures for China's S&T personnel resource development and management during the 1990's.

Enhancing S&T Security Consciousness

92FE0541C Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 23 Apr 92 p 4

[Article by Li Baotai [2621 0202 3141] of the State Science and Technology Commission: "Strengthen Propaganda on S&T Security Consciousness"]

[Text] During the process of reform and opening up, strengthening propaganda on S&T is extremely necessary, but as a part of it we should also be concerned with the importance of propaganda on S&T security.

Propaganda refers to the use of the mass media to introduce publicly a particular thing in the hope that everyone in society will have a common understanding. Security, on the other hand, refers to the intentional control of certain types of important information to make them secret and not publicly known in order to protect certain interests.

Generally speaking, unique S&T achievements having a vanguard status in the world can produce rather substantial improvements in production levels and produce relatively high economic benefits. As a result, they may become an object that everyone fights for. Thus, when

people are protecting their own rights and interests, it is best to use security measures, meaning the tight protection of all or part of the information about certain major S&T achievements for a certain period of time. All countries pay extremely close attention to the utilization of tactical measures for security to prevent others from stealing them.

Thus, when we say "security" we are not being mysterious and our relationship with everyone is not remote. The key is whether or not we have a correct security consciousness. First, the role of security is absolutely not passive, it is active. Security policies are flexible and not rigid. They are like a valve that regulates the flow of secret technology inside China and to the outside and must control the dimensions of exports, extension, cooperation, and other areas. Protecting at appropriate times and releasing at appropriate times, flexible readjustment always places it in a favorable status. Thus, we can draw this conclusion: the development of S&T inevitably carries along and requires that S&T security work serve it and provide guarantees. In contrast, S&T security work also promotes the development of S&T and enables the more effective conversion of S&T into forces of production.

Consciousness of security in our whole society at present is not very high. This is directly related to the very little propaganda and education we have done regarding S&T security. We should do more in this area, especially among all S&T workers and the relevant leaders, who must fully understand the serious consequences of neglecting security. Haven't public security departments repeatedly broken cases of illegal elements spying on and stealing China's technical secrets? Weak security consciousness can also lead to leaks of secrets in foreign affairs activities like going abroad for advanced training, lecturing, participating in academic conferences, holding exhibitions, and so on. Thus, we must strengthen education, overcome the mistaken idea that there are no secrets to protect, that secrets are hard to protect, and the lack of concern for leaking secrets, prevent behavior involving the provision of technical secrets for petty gains, establish the concept that it is a service to protect security and that leaking secrets and selling the state's technical secrets are crimes, and gradually increase the self-consciousness of all of society regarding preserving S&T secrets. Moreover, there are also security problems in public propaganda reports themselves (including books and periodicals, video and sound recordings, and so on). Abstracting units and individuals lack a concept of security and inspection by publishing organizations is ineffective, all of which can result in losses to varying degrees as a result of leaking secrets. Thus, propaganda on S&T security should be an important aspect of S&T propaganda.

CAS's Goal for Eighth 5-Year Plan

92FE0418C Beijing BEIJING KEJI BAO [BEIJING SCIENCE AND TECHNOLOGY NEWS] in Chinese 8 Feb 92 p 1

[Article by Shi Wenjie [0670 2429 1240] and Jing Haiou [2529 3189 7743]]

[Text] One of the main goals in scientific research of the CAS, as recently established in the context of goals for the 1990's, is to establish a number of research bases as focal areas and directions of the CAS and for the completion of major national and institutional missions.

In the next few years, the CAS will be working on major national and institutional projects, organize and implement the key projects in the Eighth 5-Year Plan, conduct projects in the "863" program and major basic research programs, complete major projects that use the specialty and advantage of the CAS and strive for a series of high-level, high-profit research results in 5 years, so that application and development research results may be commercialized in a timely fashion.

The CAS will also build science centers in the Eighth 5-Year Plan period. The science centers are based on the open laboratory and are another reform measure in the area of basic research. They will be characterized as open to domestic and foreign visitors and being multidisciplinary. The centers will adopt a new employment system and recruit prominent scientists from China and abroad in order to attract S&T talents to push the frontier in science forward.

In the building of 100 open laboratories, the CAS will continue to practice periodic evaluation and meritorial competition to ensure the high quality of the open laboratories. The CAS will also strengthen the organization and cooperation of open laboratories to facilitate interdisciplinary activity and the formation of priority fields. High level openness will be encouraged to attract prominent scientists from here and overseas to work in the open laboratories. Efforts will be made to increase the number of national key laboratories from 43 to about 50.

To combine the implementation of national key projects and major projects in the academy, the CAS will build 10-15 engineering research centers and strive to be included in the national engineering research center and engineering technology center programs. The engineering research centers will have the ability to tackle key problems and have intermediate testing and production capability and will be closely tied to industry and enterprise groups. They will provide an avenue for converting research results into production. They will be market oriented and will derive their operating funding from assuming national and industrial R&D missions, technology transfer, and intermediate testing and production. A beneficial cycle of promoting production with technology and vice versa will be established.

Also in the Eighth 5-Year Plan, the CAS will establish a Chinese-style ecological research network, strengthen 30 core stations and four branch research centers on water, soil, atmosphere, and biology, and a general research center. Field test instruments will be modernized and standardized. Regional development of resources, ecology, and agriculture will be improved. Basic research for ecological systems and high quality, resource-economized agricultural demonstration will be conducted. In the meantime, research on global changes will be actively pursued.

CAS S&T Development in Seventh 5-Year Plan Analyzed

92FE0418A Tianjin KEXUE XUE YU KEXUE JISHU GUANLI [SCIENCE OF SCIENCE & MANAGEMENT OF S.T.] in Chinese Vol 13 No 2, Feb 92 pp 41-45

[Article by Cao Hengzhong [2580 1854 1813] and Li Shizhu [2621 4258 2691] of the Chinese S&T Promotion and Development Research Center; responsible editor You Siyi [3266 1835 1837]]

[Excerpt] [Passage omitted] In 1989, the CAS strived to carry out the Party Central Committee's policy of "rectification and deepening the reform," improved the internal and external environment for S&T research, and steadily promoted S&T development.

I. S&T Investment Analysis and Evaluation

1. Spending on S&T Continued To Grow But at a Slightly Slower Rate

Table 1 shows that the total expenditure of the CAS has been growing every year since 1986; the rate of growth in 1987 (18.9 percent) was the highest. After 1988, the rate of growth has been declining. In 1986, the research expenditure of the CAS was 14.2 percent less than the previous year. Since 1987, the research expenditure has been growing every year. The amount of research expenditure growth was the largest in 1987 (25.4 percent), and it has been on the decline after that year. Compared to 1988, the growth rate of CAS research projects expenditure declined by 0.3 percent although, granted, the expenditure growth of 17.7 percent on projects was still very high.

Table 1. 1986-1989 Spending at CAS

	1986		1987		1988		1989	
	Amount	Growth rate (%)	Amount	Growth rate (%)	Amount	Growth rate (%)	Amount	Growth rate (%)
Total expenditure (in 10,000 yuan)	78.468	1.3	93.300	18.9	104.103	11.6	115.512	11
Research expenditure (in 10,000 yuan)	49.178	-14.2	61.657	25.4	67.096	8.8	71.422	6.4
Project expenditure (in 10,000 yuan)	—	—	34.435	—	40.635	18.0	47.826	17.7

On the whole, the expenditure of the CAS in 1989 was higher than the previous year, but the rate of growth has slowed down. This is mainly due to the fact that the rate of growth of CAS income has gone down. In 1989, the total income was 1.31031 billion yuan, which represented a growth of only 3.5 percent over the previous year. Compared to 1988, the growth rate has dropped by 20.5 percent.

In 1989, the average project expenditure at CAS was 58,000 yuan per project. The amounts for basic research, application research, and experimental development projects were respectively 41,000, 63,000, and 87,000 per project, with experimental development projects receiving the highest funding. Compared to 1988, the average funding per project at CAS increased by 7.4 percent. The growth in application research project expenditure was the greatest, at 18.9 percent, while the level for basic research and experimental development research held constant.

2. Steady Growth in Project Personnel

Table 2 shows that the growth rate for project personnel in 1989 was greater than the growth of total S&T personnel.

Table 2. Project Personnel in 1987-1989

	1986		1987		1988		1989	
	Number	Growth rate (%)	Number	Growth rate (%)	Number	Growth rate (%)	Number	Growth rate (%)
Project personnel	—	—	29,125	—	29,565	1.5	31,105	4.9
Total S&T personnel:								
Scientists, engineers	—	—	22,989	—	24,477	6.5	26,115	6.7
Other S&T staff	—	—	4,733	—	3,543	-25.1	3,434	-3.1

In terms of types of projects, the growth of personnel deployment in 1989 for basic research projects and experimental development projects were respectively 7.1 percent and 15.0 percent. The magnitude of growth was large, especially in experimental development projects. These data showed that the CAS, while it continued to strengthen basic research in 1989, has greatly strengthened experimental development activities that were closely tied to the national economy in order to serve the economic development.

In 1989, personnel associated with application research projects in the CAS decreased 0.5 percent as compared to 1988. However, personnel in application research projects still accounted for 46.0 percent of the total S&T personnel. Application research is still the main area of study at the CAS.

3. Capital Construction Continued To Grow, But at a Slower Pace

In 1989, the CAS invested 271.32 million yuan on capital construction and actually completed 293.84 million yuan of capital construction. A total of 298,743 square meters of building were completed, including 150,000 square meters of residence buildings, and 77,950 square meters of research buildings. Compared to 1988, there was a 4 percent growth in capital construction, and a 20.9 percent growth in building area completed. Among the large- and medium-scaled projects, the Lanzhou Heavy Ion Accelerator Project passed state certification, the Beijing Electron-Positron Collider and the Shenyang Robotic Demonstration Project have the early preparation phase for state certification. The 2.16 meter astronomical telescope, the largest in the Far East, has been completed at the Xinglong Station of the Beijing Observatory. Small-scale projects included the completion of the Metal Corrosion Prevention Institute, the Psychology Institute, the Theoretical Physics Institute, and the Advanced S&T Center.

II. Analysis and Evaluation of S&T Activities

With the effort of all the staff and workers, the CAS achieved good progress in 1989 in its scientific research and other S&T activities.

1. Scientific Research Continued, Total Number of Projects Increased

In 1989, the CAS conducted a total of 8,287 projects, which represented a 9.3 percent growth over 1988. After

a growth of 6.9 percent in 1988, the number of projects grew another 2.4 percent in 1989. Of these projects 2,080 were new starts and 1,677 projects were completed in 1989.

Among the projects started in 1989, the breakdown for basic research, application research, and experimental development projects was 38.4 percent, 44.2 percent, and 10.3 percent, respectively. Other types of projects, including manufacturing and design, promotion and demonstration, technical services, and production activities, accounted for 7.1 percent. In comparison, the breakdown figures of 1988 were 36.8 percent, 45.4 percent, 11.1 percent, and 6.6 percent, respectively. Compared to 1988, the basic research category had a growth while application research and development projects had a slight decrease.

2. S&T Projects Are Properly Implemented

As a comprehensive research center for natural science, the CAS assumed the responsibility for China's "Seventh 5-Year Plan" project, "863 High-Tech" development project and the national natural science foundation project. In addition, the CAS also implemented its own major projects and top priority projects. In 1989, the CAS strengthened its organization and coordination of implementing the projects, timely evaluated and assessed the major research results.

(1) National Key S&T Projects

In the "Seventh 5-Year Plan," the CAS participated in 47 items and 145 subjects of research work. To concentrate personnel, finance, and material resources in obtaining significant results the State Planning Commission formulated the "214 project" (214 refers to 20 items on technologies and facilities, 100 items on new technologies and 400 items on new products), which was used as a main target for the national key S&T projects in the Seventh 5-Year Plan and as a fundamental evaluation standard. During the "Seventh 5-Year Plan" period, the CAS assumed four items on technologies and facilities, 12 on new technologies, and 52 on new product development in the "214 project." By the end of 1989, there were 90 certified research results and intermediate results.

In September 1989, the State Planning Commission, the State Science Commission, and the Ministry of Finance jointly recognized outstanding achievements of the Seventh 5-Year Plan key projects. Among the 210 projects recognized, 13 of them were directed by the CAS and the CAS participated in 22 of them.

(2) The "863" High-Tech Plan Project

In the "863" plan, the CAS participated in all seven areas and 15 topics of research work. Of the 131 tasks carried out, the CAS participated in 98 of them and led 48 of the tasks.

Sixty research institutes in the CAS conducted 355 research topics in the "863" plan; 15 institutes conducted 10 or more research tasks. Almost all the tasks were completed on time or ahead of schedule; this performance was praised by the expert committee. In the biotechnology area, the CAS played important roles in developing genetic-engineered hepatitis B vaccine and study of genetic-engineered interferon, interleukin-2, and producing disease-resistant tobacco plant. In the information and opto-electronics area, the expert committee evaluated 56 research tasks in 1989. Five of the seven class I topics in which the CAS led or participated scored crucial breakthroughs. Two tasks in signal acquisition and real time processing were both led by the CAS.

(3) Major Projects in the National Natural Science Foundation

In the Seventh 5-Year Plan, the National Natural Science Foundation planned to fund 84 major projects with a budget of 130 million yuan. As of June 1989, 66 projects were approved and 33 of them were led by the CAS.

By the end of 1989, more than 90 percent of the Foundation projects conducted by the CAS were completed according to schedule and produced many good results.

(4) Top-Priority Projects and Major Projects in the CAS

Four top-priority projects started in 1988 continued to make good progress in 1989. These projects were the Huang-Huai Hai project, the gold project, the superconductivity project, and the production of olefin from methanol.

In the Huang-Huai Hai project, the main thrust is the treatment of medium and low yield land and the development of wasteland. In 1989, 28 10,000-mu experimental demonstration zones were developed and the work area was enlarged from three counties to 44 counties. In the bidding for 10 10,000-mu demonstration zones in Henan Province, the experiment/demonstration zones proposed by the CAS in Fengchiu, Yanjin, and Fanxian for the treatment of salt land, sandy land, and riverback low land were awarded the bids.

New progress was made in the basic research and application research of high temperature superconductor materials. Resources and personnel were given to the research of new materials, superconducting thin films, high Tc wire fabrication, and the research of material structure, physical, and chemical properties, and superconductivity mechanism. This research has produced world-class results.

Between 1988 and 1989, the gold project made important progress in the theory of ore formation, new technology, and production extension. In 1989, some adjustments were made based on the fund allocation. The priority was redefined and efforts were made to complete the goals set down previously.

The intermediate testing of low carbon olefin production from methanol progressed quickly; earth work of the main body construction has been completed, reaction system unit, zeolite gain synthesis unit, and catalyst preparation unit have all reached the assembly stage. Almost all the non-standard machining facility and form setting facility have been on site. A hot run will be made in 1990.

(5) Military Engineering Projects

Based on the 3-year experience of 1986-1989, the CAS strived to put major military engineering research on a solid basis in 1989. Two major contracts were signed. As of the end of 1989, the CAS has conducted more than 20 major military engineering projects. In addition, the CAS has also conducted some small batch production tasks for some equipment.

3. R&D Progressed Steadily in Consolidation and Reorganization

The mission of S&T development progressed on different fronts at different levels.

In the 6 years from 1984 to 1989, the cumulative investment of S&T development at the CAS was about 140 million yuan. Most of the developments were in the following areas: 1) Establish a supportive environment for S&T development; 2) develop cooperation with relevant provinces, municipalities, and industrial departments; and 3) establish S&T development companies.

In 1985, the CAS and the Shenzhen municipal government jointly started the Shenzhen Industrial Park. By the end of 1987, the initial phase of the park's construction was basically completed. The park became China's first S&T industrial park aimed at supporting export-type high-tech enterprises. The park had a total area of 3.2 square kilometers and, by the end of 1989, had developed 200,000 square meters. Work is underway for the phase II development of 920,000 square meters. The park has attracted more than 20 economic entities and US$50 million of foreign capital. Some high-tech products have acquired large-batch production capability.

In 1987, the CAS and the State Economic Commission jointly invested in the establishment of a Science and Technology Advancement and Economic Development Foundation. In the 3-year period of 1987-1989, a total of 112 million yuan was invested by the CAS, the State Economic Commission, the State Planning Commission, and the Chinese Industry and Commerce Bank. This money was used for S&T development loans and supported most of the cooperative projects between the CAS and large industries or local enterprises. Almost all the projects have shown initial results; some of them have acquired considerable production capability.

At the end of 1988, the CAS formed a S&T finance company. By the end of 1989, more than 30 million yuan were provided to the various research institutes and companies of the CAS by adjusting idle funds within the CAS and by borrowing. This has served as useful financial backing for the development work in the CAS.

In recent years, the CAS has supported a series of cooperative development projects between research institutes of the CAS and companies or local enterprises. These supports were provided in the form of cooperation, loans, and investment. Considerable economic and social benefits were derived from these supports. In 1989, the CAS made new progress in the cooperation with petroleum, automotive, metallurgy, and chemical industries in Hunan, Shandong, Zhejiang, Fujian, Xinjiang, Liaoning, and Tianjin. The CAS had more than 3,000 "lateral" technical contracts with an income of 251.183 million yuan. Out of the last amount, 174.399 million yuan came from sponsored research and 37.924 million yuan came from technical result transfer income. Compared with the previous year, the "lateral" technology income of the CAS dropped 14.8 percent in 1989. The cause of the drop may be closely related to the tight economic policy of the government and the soft market.

Since 1983, the CAS has established a number of S&T development companies through loans, loan guarantees, investment, personnel deployment, and administrative services. This has paved the road for the commercialization of the research results of the CAS. Up to December 1989, there were a total of 399 companies, 2.8 percent more than last year. At the end of 1989, the total number of workers has reached 16,605, or 41.7 percent higher than the previous year. Out of the total number of workers, 14,634 were on fixed contract, or 71.0 percent greater than the previous year. Technical workers with a high school education amounted to 5,337, or 26.9 percent higher than the year before. These companies did 1.241433 billion yuan of business in 1989, which was 27.5 percent higher than the 1988 level. In 1989, the CAS companies paid state tax of 46.857 million yuan, which was 51.5 percent more than the year before.

4. International Cooperation and Exchange Activities Moved Steadily Forward in Adverse Environment

The incident in late spring and summer of 1989 has greatly affected the CAS's international cooperation and exchange activities. However, the CAS has still made good progress in S&T exchange by actively following the leads created in the past and maintaining contacts with the outside. In 1989, CAS personnel have made a total of 4,077 foreign visits (21.9 percent more than in 1988) and received 2,097 visitors (59.6 percent less than the previous year).

III. Analysis Evaluation of S&T Results and Awards

1. CAS Registered Research Results Began To Make a Small-Scale Increase After 3 Years of Consecutive Decrease

In 1989, the CAS registered a total of 1,053 research results, which was 2.4 percent higher than in 1988. Among those results, 877 were major results, which was 1.2 percent more than in 1988. Of the total results, 196

(or 18.6 percent) were from basic research, 754 (or 71.6 percent) were from application research, and 103 (or 9.8 percent) were from development projects. Seventy-five of these results (7.1 percent) were of leading international standard and 399 of the results (37.9 percent) were of advanced international standard. The combined number of results in these two categories remained about the same as in 1988.

2. A Number of S&T Results Received National Awards

In 1989, the CAS received four National Invention Awards, including three third prizes and one fourth prize. The CAS also received 26 National S&T Advancement Awards, including one first prize, nine second prizes, and 16 third prizes. Compared to 1988, the number of National Invention Awards received by the CAS decreased by 63.6 percent and the ranks of prizes received were also lower. The number of National S&T Advancement Awards decreased by 10.3 percent and the number of first prizes also decreased by three. Also in 1989, the CAS gave 127 Institute Natural Science Awards, including 20 first prizes. In addition, 238 Institute S&T Advancement Awards were given in 1989, including two special prizes and 21 first prizes. Compared to 1988, the number of Institute S&T Advancement Awards decreased by 34.1 percent.

3. The Number of Scientific Papers Increased Slightly

In 1989, the CAS system published a total of 13,849 papers, which was 3.5 percent more than in 1988. The number of publications has increased since 1987 and the rate of growth was greater than 10 percent in 1987 and 1988. In comparison, the rate of growth was less in 1989.

4. The Volume of S&T Writing Has Decreased

In 1989, the CAS published 92.14 million words of S&T writings in 356 volumes. These represented decreases of 6.6 percent and 32.3 percent, respectively. Among these printings, 3.28 million words, or 18 volumes, were translated into foreign languages. These last figures were lower than those in 1988 by 50.8 percent and 52.6 percent, respectively. The decreases were very large.

In summary, the scientific and technological endeavors in the CAS have made certain progress in 1989 and continued to grow from the 1988 level. Good advances were made in scientific research and other S&T activities. Results of S&T research have increased to various degrees and the technical level has also improved. However, it should be noted that the slowing down of China's economic development in 1989 and the financial shortage in China have caused the income growth of the CAS to slow down. This has hampered the development growth of S&T activities in the CAS and limited the advancement of S&T standards. This slow-down has had adverse effects on the development of the S&T endeavors in the CAS.

CAS Vigorously Preparing for 21st Century S&T Competition

92FE0418D Beijing BEIJING KEJI BAO [BEIJING SCIENCE AND TECHNOLOGY NEWS] in Chinese 29 Feb 92 p 1

[Article by Shi Wenjie [0670 2429 1240]]

[Text] The Chinese Academy of Sciences (CAS), while paying great attention to both the leading role of senior scientists and the main role of middle-aged scientists, also pays attention to fostering and promoting young talents in an effort to attract 100 outstanding young leaders and 1,000 superb workers in the Eighth 5-Year Plan period.

In the area of graduate student education, the CAS officially implemented the graduate education and degree evaluation system, promoted the Ph.D. and M.S. disciplines and postdoctoral mobile stations. Last year, the CAS added two Ph.D. granting units, 13 Ph.D. level specialties, five M.S.-granting units, 46 M.S. level specialties, 171 Ph.D. advisors, and established an associate advisor system for Ph.D. students. To date, the CAS has 85 Ph.D.-granting units, 197 Ph.D. specialties, 119 M.S.-granting units, 359 M.S. specialties, 790 Ph.D. advisors, 16 new postdoctoral mobile stations (a total of 62) and 122 academic disciplines. As an important national base for cultivating and providing advanced specialist personnel, the CAS has played its proper role.

In the area of assigned jobs to personnel returning from training abroad, the CAS has broadened the utilization range for overseas education fund to include mathematics, physics, chemistry, biology, natural resources environment, and technology science. The number of people to be assigned overseas for advanced education has increased from 35 in 1990 to 90 in 1991. In order to attract outstanding Chinese students from overseas, the CAS has established a talent bank of outstanding students. Eighty candidates were recommended by various units and the CAS leadership has approved 13 of them.

In 1991, units in the CAS actively implemented a policy to encourage the training and support of outstanding young personnel and to provide them with better working and living conditions. A large number of young people have been made laboratory and project leaders. The decision to devote 10 percent of residence housing built by the CAS to superior young talents is beginning to be implemented. Units in the Shanghai branch assigned 6,000 square meters of residence to outstanding young workers and technical staff in one shot. The Beijing Computation Institute set aside 20 percent of the 10,000 square meters of residential housing for S&T staff with special contributions, especially young staff. Some other branches and research institutes are also making similar arrangements. This series of measures favored the motivation of young technical workers and stimulated their sense of mission. An atmosphere of valuing the cultivation of talents and letting young people play their role is beginning to form in the CAS.

As a result of the attention and effort on training and selection, a group of young workers has made outstanding performance and received praise and recognition. In 1990, the CAS had a total of 25 young scientists receiving the "CAS Young Scientists Award," five young workers 35 years or below in age received special subsidy approved by the State Council, and 152 graduate students received the dean's scholarship, including 10 special awards. In the change of guard at the research institutes and open laboratories, a generation of capable young people assumed the leadership positions.

Nanjing University Becomes Important Base To Foster Prominent Scientists

92FE0418B Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 31 Jan 92 p 1

[Article by Fang Yanming [2455 1693 2494]]

[Text] Nanjing University is reaping results of research and capable talents by supporting middle-aged and young faculty. Based on statistics compiled by the State Science Commission from the authoritative citation index in the world, Nanjing University ranks among the top three universities in China for the number of international publications. Recently, six more professors were elected council members of the Chinese Academy of Sciences, which accounted for 11.32 percent of the 53 newly elected members from universities in China. These achievements were praised by people in different professions.

We interviewed the leaders of Nanjing University to find out how they managed to achieve such first class results and cultivate such first class people. According to the leaders, the main reason was reform and openness and the university's big effort to provide their researchers with a sound research environment.

The university gave outstanding middle-aged and young researchers high priority in funding and opportunities to study or visit abroad. To date, more than 1,000 teachers from Nanjing University have gone abroad to study, teach, or collaborate. These young and middle-aged faculty were encouraged to go for the frontier in their fields. The university also coordinated with old experts in establishing a "talent chain" and let the young and middle-aged researchers take the lead and play the main role. The solid state physics research led by Professor Feng Duan [7458 4551] was praised as one of the "five stars" in Nanjing University. His laboratory was later qualified as a key national laboratory. As laboratory director, Professor Feng let his student Min Naiben [7036 0035 2609] take care of the daily business and very quickly made Min a premier figure in crystallography here and abroad. Recently, Min was appointed the principal scientist for China's major basic research program and was also elected council member of CAS. There were as many as three council members of CAS under Professor Feng. Professor Zhang Shuyi [1728 3219 0308], a former graduate student of CAS council member Wei Rongjue [7614 2837 3635], has made outstanding achievements in acoustic research. Her laboratory was twice highly praised by Nobel Prize winner Professor Bardeen. She was also elected council member of CAS recently. The chemistry department has five CAS members. Professor Sun Zhongxiu [1327 6988 4423] of the computer science department has attracted attention in software research. He is now vice president of Nanjing University and president of the Jiangsu Science Association. He was also elected council member of CAS recently.

Caohejing Development Zone Update

92FE0418E Beijing GUANGMING RIBAO in Chinese 20 Feb 92 p 1

[Article by Zhang Yifu [1728 4182 1788]]

[Text] In the development and competition of high technology industry, the Shanghai Caohejing emerging technology development zone attracted the world's attention by achieving an industrial value of production of 2.534 billion yuan and creating 80.44 million yuan in 1991.

The Caohejing development zone, occupying an area of 5.9 square kilometers, now has 50 "Sanzi" (foreign joint venture) enterprises, which account for 45 percent of the 112 enterprises in the zone; $203 million of foreign currency were brought in. A batch of small high- and new-tech industrial zone and enterprise groups have formed in the zone. Here is China's most advanced microelectronics industrial zone, producing large-scale integrated circuits on 4-5-inch silicon wafer with 2-3 micron chip fabrication technology; the annual output has reached 120 million components. In the fiber optics and modern communication zone, one company alone had a sales value of $16 million last year; it was contracted to build a 220,000 programmed telephone system for Beijing. The computer software and hardware production zone has obvious economic benefits. The SPEC200 programmed system produced by the China-U.S. joint venture Shanghai Foxboro Company has met the international standards for nuclear power plant control systems and provided the automated control system for China's first Qingshan nuclear power plant. This company has also sold 2,147 nuclear-grade products back to the United States. In 1991, the sale value of the company was 90 million yuan.

The Caohejing development zone attracted attention here and abroad with its multi-disciplinary high- and new-tech industries. China's first biotechnology research and development and intermediate testing base began here. More

than 30 products developed by this biotechnology base, including genetically engineered human growth hormone and diarrhea vaccine for young animals have been put into production. The industrial unit started by the Ministry of Aeronautics and Astronautics Industry has made a name in China and overseas with its Changzheng-3 and Changzheng-4 rockets and on-board electronic products. The newly established Shanghai Gaochuang Science and Technology Development Corporation, in collaboration with Fudan University, Shanghai Jiaotong University, and eight other universities has "incubated" 17 new high-tech companies for robots, sensors, opto-electronic integration, new materials, and medical devices. This company pioneered the S&T industrialization of higher education in the "S&T entrepreneur village" in the Caohejing development zone.

Almost 100 members of the Pacific Economic Cooperation Conference visited Caohejing zone recently. They believed that an environment for high-tech development has formed here. Shanghai has become the center for science and technology, and industrial technology on the west shore of the Pacific Ocean and Caohejing development zone is a symbol for Shanghai.

China, ESA Cooperate on Multipoint-Detection Satellite Project

92P60333 Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 22 May 92 p 1

[Article by Xiao Jun [2556 0689]: "Curtain Drawn Back on China-ESA Cooperation on a Multipoint-Detection Satellite"]

[Summary] A joint China-European Space Agency (ESA) project involving a multipoint-detection satellite was recently unveiled in Beijing. ESA's Space Sciences Advisory Committee Chairman Prof. Southwood and a delegation of scientists from Britain, France, Germany, Sweden, Austria and other nations arrived in Beijing for joint exchanges and consultation with Chinese scientists. The group has decided to build a China Multipoint Satellite Scientific Data Center and computer network, as well as to engage in other development projects. The multipoint satellite system, a project of ESA and NASA, is scheduled to be launched about 1995, and includes four satellites forming one four-sided body. This satellite system will be used to detect fine 3D particles in the plasmas and electromagnetic fields of the Earth's magnetized [atmospheric] layers, and is one of the most important space detection activities slated for the 1990s. Chinese Academy of Sciences' Space Center research fellow Liu Zhenxing [0491 2182 5281] initiated the contact with ESA officials in November 1990 via a formal indication of China's desire to participate in the project, and the ESA then approved the request. This marks China's first participation as a formal member from beginning to end in an international cooperative space project.

Preliminary Experimental Study of Electromagnetic Missiles Conducted

92P60325A Chengdu DIANZI KEJI DAXUE XUEBAO [JOURNAL OF UNIVERSITY OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA] in Chinese Vol 21 No 1, Feb 92 pp 92-97

[Article by Ruan Chengli [7086 2052 4409], Wan Changhua [8001 7022 5478], and Yuan Naichang [5913 0035 2490] of the University of Electronic Science and Technology of China (UEST), Chengdu 610054: "Preliminary Experiment With Electromagnetic Missiles"; MS received 25 Apr 91, revised 15 Jun 91]

[Abstract] In 1985, the Harvard University physicist T. T. Wu propounded the theory of electromagnetic (EM) missiles,[1] or slowly decaying pulsed EM waves propagating through free space. In 1988, the Chinese scientist H. M. Shen (Shen Huoming) conducted an experimental study of EM missiles,[2] a technology which has applications in counter-stealth impulse (ultra-wideband) radar, long-range communications, and directed energy weapons. According to our understanding of this Chinese visiting scholar's experiment, the basic considerations involved in implementing such a system are: (1) sufficiently short pulse-source output pulse rise time as well as sufficiently large amplitude and (2) availability of a wideband sampling oscilloscope to receive and record the pulse signal.

To solve the first problem, we at UEST independently developed the XB7 gas-discharge-tube signal source, which provides a large-amplitude short-rise-time narrow-pulse wideband voltage pulse source. We also employed a domestically made SQ-27 sampling oscilloscope in our experiment, along with an HP8510 network analyzer. The experimental apparatus is shown in Figure 1. The output signal from the pulse source is fed via coaxial cable to the transmitting antenna, which puts out a spherical wave that bounces off the parabolic reflector and is directionally transmitted to the receiving antenna. The receiver feeds the received signal via coax to the sampling oscilloscope and the X-Y recorder. The basic system (antennas and reflector) is contained on a 4.8 m x 2 m rectangular metal platform which provides conditions simulating free-space transmission, while the pulse source, cabling, and instruments are housed below the platform or at a distance away. The sampling oscilloscope indicates the pulse-source voltage pulse waveform (shown in Figure 2) has a rise time of 0.28 ns, a pulse width of 0.68 ns at 50 percent amplitude, and a peak amplitude of 2,200 V.

The transmitting and receiving antennas are V-shaped single-sector conical antennas, which have been shown to be excellent for transmitting and receiving pulsed spherical EM waves.[3,4] The HP8510 indicates that the antenna's input standing wave ratio (SWR) ρ does not exceed 2.0 in the 300 MHz - 20 GHz range. The experimentally measured input SWR[4] is shown in Figure 3.

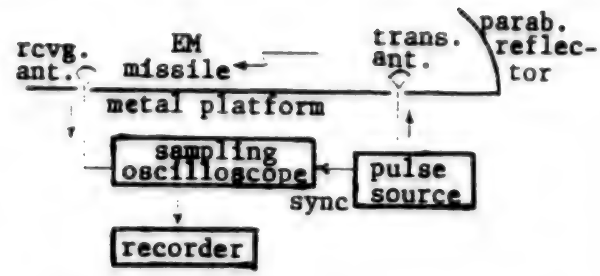

Figure 1. EM Missile Experimental System

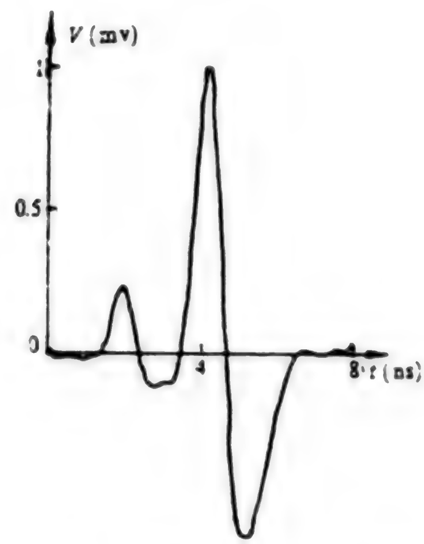

Figure 2. Pulse-Source Voltage Pulse Waveform

Two experiments were conducted: a single-frequency CW experiment and a pulsed wave experiment. For the former, the XB7's operating frequency was 1.46 GHz (1.98 GHz was also tried, with identical results). The transmitting antenna has a 2φ subtended angle of 120° and length L of 5.5 cm, while the receiving antenna has $2\varphi = 110°$ and L = 11 cm. The Rayleigh distance at 1.6 GHz is easily computed to be $L_R = 52$ cm. A typical single-frequency CW transmission characteristic curve is shown in Figure 4. With the same apparatus, we then conducted the pulsed wave experiment. The pulse-source output voltage pulse has a 3 dB bandwidth of 0-1.25 GHz. The characteristic curve for the pulsed wave transmission is shown in Figure 5.

The results indicate that the single-frequency continuous wave past the Rayleigh distance decays (as predicted) according to the inverse square law of the range (r^{-2}), while the pulsed EM wave decreases more slowly ($r^{-2\varepsilon}$, where $0 < \varepsilon < 1$). Moreover, foreign studies of EM missiles are based on single-excitation signals, while we

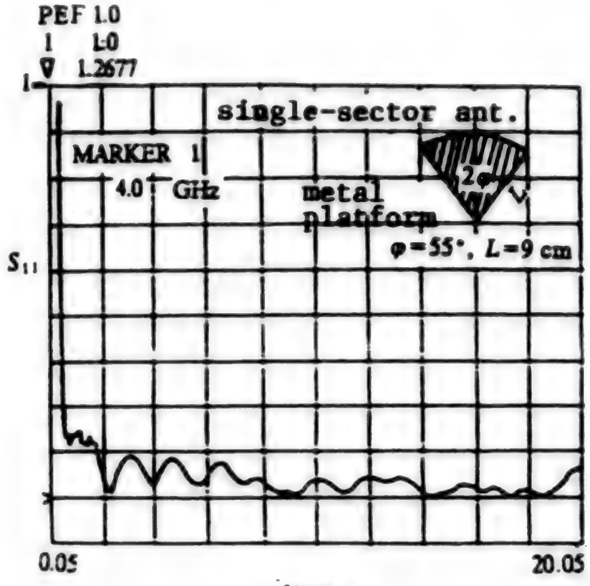

Figure 3. Measured Input SWR of V-Shaped Conical Receiving Antenna

have extended the theory to periodically repeated signals, which retain the EM missile effects.[4] Our additional theoretical studies are given in references 4-12.

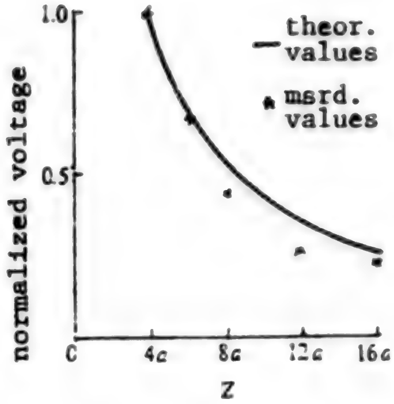

Figure 4. Exper. Curve for Single-Frequency CW Transmission Characteristics

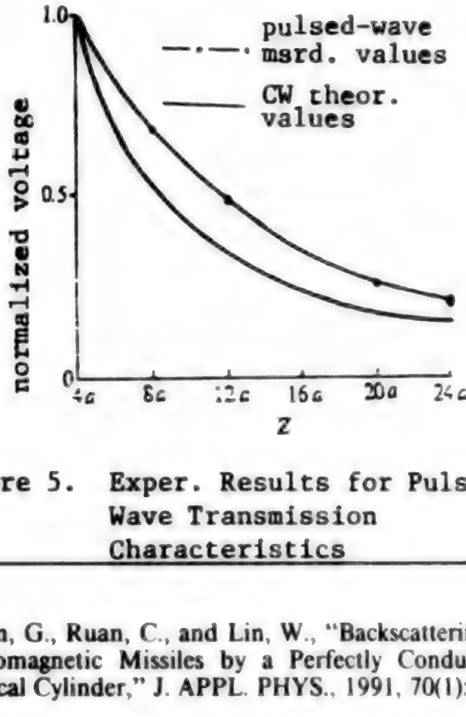

Figure 5. Exper. Results for Pulsed-Wave Transmission Characteristics

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Advanced Image-Display Workstation Developed for Command

92P60331 Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 11 May 92 p 3

[Article by Tan Keyang [6223 0344 2254]: "University of S&T for National Defense Develops Command General-Purpose Image-Display Workstation; Its Technical Performance Has Reached International State-of-the-Art"]

[Summary] A state-of-the-art "command [C^3I] general-purpose image-display workstation" developed by engineers at the University of Science & Technology for National Defense (USTND) was unveiled at USTND in Changsha on 21 April, indicating a giant step forward for the nation's military command automation effort. This workstation, which can receive and display TV imagery, static images, and sound received from a variety of video display systems, is suitable for receiving Chinese-character texts, reports, tables, and situation plots, as well as for teleconferencing. The station uses a multi-format-capable monitor—the first such domestically developed monitor—with a field frequency of 40-110 Hz and a line frequency of 15-66 kHz; its automatic tracking ability is quite high. Overall performance has reached that of comparable foreign-made products now in use. Besides military command, transportation, and flight, applications include automated management for industrial firms. The 10-odd-member USTND engineering group, led by Assoc. Prof. Yu Lifu [0151 3810 1381], developed this new workstation in a 2-year-plus effort without the benefit of reference data, since information on this technolog, is restricted by foreign nations.

Hefei Institute Studies Nanoparticles

*40100062 Beijing CHINA DAILY in English
22 Jun 92 p 5*

[Article by Zhou Jie]

[Text] Scientists are thinking smaller and smaller.

The field of nano science promises to spark an industrial revolution in the next century.

Born in the late 1980s, nano science and technology enables scientists to manipulate atoms and molecules and is one of the hottest developing sciences of the past few years.

The science involves particles of between 0.000001 and 0.0001 millimeters. (One nanometer equals 0.000000001 meter.)

"These tiny structures open up huge application possibilities for the future," said Professor Zhang Lide, Deputy Director of the Hefei-based Institute of Solid State Physics (ISSP) under the Chinese Academy of Sciences.

Material scientists have found that metals, non-metals, organic substances and chemical compounds, when powdered to nanoparticles, often possess many special physical properties, which their conventional solid forms do not have.

"It is fantastic. These super fine particles possess unusual optical, electromagnetic, thermodynamic and acoustical characteristics. They have even been used to make aeroplanes invisible to enemy radar," said Zhang.

Nanoparticles, with diameters ranging from one to 100 nanometers, are about 100 times smaller than red blood cells. They can only be observed under a transmission electron microscope (TEM).

"Several tens of thousands of such particles can fit on the tip of a human hair," said the material scientist.

Each particle may contain from dozens to several tens of thousands of atoms. "So here, we study the world between microstructure and macrostructure," Zhang said.

Materials consisting of nanoparticles can be extremely hard, such as those making up our teeth.

This has provided new hope for material scientists who, for almost a century, have tried to rid ceramic of its brittleness.

This quest is rapidly being realized by German and American scientists who have developed several tough nano-porcelains.

Nanoparticles can also be used as catalysts to improve reaction efficiency and control over reaction speeds and temperature.

Nanoparticles of certain metals or compounds such as aluminum, if added to certain engine fuels can improve burning efficiency by several times.

The use of these particles promises the development of new high-density magnetic recording materials. Just a few particles can store a piece of information. Scientists predict research may one day enable all the books in the United States Library of Congress to be stored on a silicon disc no bigger than a gramophone record.

The Matsushita Electric Industrial Company in Japan has developed nanoparticle video tapes, which provide high resolution pictures.

Nanoparticles and nanostructured solids are perhaps the most promising material in the field of sensor development.

The relatively large interface of nanostructured solids makes them highly sensitive to heat, light and moisture.

Scientists around the world are working to develop nanoparticle sensors to detect spirits, gasoline, coal gas, and automobile gas emissions.

The most fantastic and revolutionary part of this mini science is nano-robots.

The nano-robot, whose parts are directly assembled from atoms and molecules smaller than a human red blood cell, may bring about a technological leap and boost medical science.

"Just imagine some super tiny machines, controlled by microelectronic techniques, travelling along our blood vessels, obliterating viruses, cleaning up extra fat in the heart, dredging blocked vessels and performing general medical checkups," said Professor Zhang.

This may mark the cure of many of current diseases.

What is more, nano science and technology may one day change the world as we know it by creating new biological products through more advanced genetic engineering.

Scientists foresee that man may create large molecules with special functions at will. This is what scientists called nano-biology, a branch of science no more than two years old.

"We may find different food at our dinner table in the next century," said Zhang.

The new science has aroused great attention in international scientific circles.

Prominent Chinese physicist Qian Xuesen said, "Nanometer-sized structures will be crucial to scientific and technological development. It will result in a technological and industrial revolution in the 21st Century."

Professor J. Armstrong, IBM's chief scientist said that, just like micro-electronic technology led to the information revolution in the 1970s, nano science will be the core of the next century's information technology.

It has been schemed into programmes in Germany, the United States, Japan, Britain, and other western countries.

In China, nano science and technology was attended by great concern soon after its emergence. It is also one of the 863 national high-tech programmes. More than 30 institutions and universities in the country have reportedly started research in nano-material. Two national symposia on this field were held in 1990 and 1991.

The ISSP is one of the leading forces in the country's nano-research.

Young researchers at the institute have developed an "oven" to produce nanophase materials with clean interfaces.

The small device comprises an ultra-high vacuum that can reach as high as 47,000 atmospheric pressures, according to Professor Wu Xijun, an expert on interfacial physics with the ISSP and one of the chief designers of the "oven".

Wu said the machine is the first of its kind in China and is among the best in the world.

In this pure environment and under high stress, several nano-metals have been "cooked", such as copper, silver, germanium, titanium dioxide, and calcium fluorine.

Calcium fluorine, if produced at nanometer level, becomes an ionic conductor. Wu believes the material may be developed into new and better rechargeable batteries.

Scientists are fascinated by nano-sized semiconductor germanium and silicon, which can emit light under certain conditions.

Wu predicted this may allow scientists to join photoelectronic technology with microelectronic technology, which might lead to super small computers in the future.

Meanwhile, Professor Zhang is leading a group to study the possibility of developing more efficient lighting systems by adding nano-sized alumina to fluorescent lamps.

"The current period is one of the major breakthroughs in this new science," Zhang said.

Cloning, Sequencing of Glucoamylase cDNA From *Aspergillus niger* and Its Expression in *E. coli*

40091015A Guangzhou ZHONGSHAN DAXUE XUEBAO [ACTA SCIENTIARUM NATURALIUM UNIVERSITATIS SUNYATSENI] in Chinese Vol 31 No 2, Apr 92 pp 67-76

[English abstract of article by Li Wenqing [2621 2429 3237], Luo Jinxian [5012 6651 6343], et al. of the Department of Biology and Biotechnology Research Center]

[Text] A cDNA library was constructed using poly(A)$^+$mRNA of *Aspergillus niger* 3758 as template and phase λgt 10 DNA as vector. The glucoamylase gene was screened using a 456 bp DNA fragment coding for 152 amino acid residues of *A. niger* glucoamylase as probe. Eleven positive plaques were identified by hybridization in situ with ^{32}P-labelled probe. DNA from 6 of the 11 positive clones were isolated and restriction analysis and Southern hybridization were done. All of these phages DNA carry inserts with different sizes and hybridize with the DNA probe, which indicate the cloning of glucoamylase gene of *A. niger*. The physical map of the 2.1 kb cDNA fragment was constructed and its nucleotide sequence determined. From the sequence analysis, the cloned fragment consists of the 5'-noncoding sequence, the intact structural gene coding for glucoamylase and the 3'-nontranslated region. The cloned cDNAs were transferred to λgt 11, the resultant phages were used to infect *E. coli*. The plaques formed were transferred to nitrocellulose filter and probed with *A. niger* glucoamylase antibody. Positive result was obtained from the plaque carrying the 2.1 kb fragment. This fragment was also ligated to expression plasmid pPL2 which was then transformed to *E. coli* JF1125, a new protein band was found by SDS-PAGE. These results show that the cloned glucoamylase cDNA was expressed in *E. coli*.

PCR Amplification, Cloning and Expression of the Gene Coding for CD_4 V_1-V_2 Domains

40091015B Beijing ZHONGGUO YIXUE KEXUEYUAN XUEBAO [ACTA ACADEMIAE MEDICINAE SINICAE] in Chinese Vol 14 No 2, Apr 92 pp 79-84

[English abstract of article by Li Jianliang [2621 1696 5328], Huang Houzhe [7806 0624 0772], et al. of the Institute of Basic Medical Sciences, Beijing]

[Text] We describe the use of a modified technique of polymerase chain reaction (PCR) for facilitating cloning and expression of a cDNA fragment encoding CD_4 V_1-V_2 domains. the modification includes introducing suitable signals to start primer and halt primer of the target gene as indicated in Figure 1. After verified by DNA sequencing, the amplified DNA fragment was cloned into prokaryotic expression vectors containing λP_L promoter. The screened clones were induced to express the target fragment V_1-V_2 of CD_4 gene and the expected gene product was estimated to be 8 percent or 10 percent of the total cellular proteins.

```
Start primer (SP)

                         start codon
                              |
5'        AAGCTTGCCATATGaagaaagtggtgctgggcaaaaaa        3'

          HindIII     NdeI        CD4 gene sequence

Halt primer (HP)

                      stop codon
                          |
5'        GGATCCTATTACAGGCTtctggaaagctagcaccacgatgt     3'

          BamHI          AlwNI      CD4 gene sequence
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Figure 1. Sequences of Primers for Amplifying the CD_4 V_1-V_2 Fragment by PCR

Continuous Replication and Expression of the Hepatitis D Virus Genome in Human Hepatoma Cells

40091015D Beijing ZHONGHUA WEISHENGWUXUE HE MIANYIXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 12 No 2, Apr 92 pp 74-77

[English abstract of article by Tang Hong [0781 4767], Zhao Liansan [6392 6647 0005], et al. of the West China University of Medical Sciences]

[Text] With calcium phosphate method, human hepatoma cell line of Qidong, China (QGY-7703) was cotransfected by a recombinant plasmid containing full length trimer of HDV cDNA ($pSVLD_3$) and a plasmid containing neomycin-resistant gene (pSV_2-neo).

A stable human hepatoma cell culture system (QGY-W913) which allowed continuous replication and expression of HDV RNA was obtained. This cell culture system should be useful in further studying on the replication and packing mechanism of HDV. Our results also demonstrated that HDV RNA could replicate and express without the assistance of hepadnaviruses (e.g. HBV). The replication of HDV genome might not have a direct cytopathic effect.

Expression of Recombinant Hepatitis D Virus Antigen in *E. coli* and Its Antigenicity Analysis

40091015C Beijing ZHONGHUA WEISHENGWUXUE HE MIANYIXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 12 No 2, Apr 92 pp 69-73

[English abstract of article by Jin Ling [6855 7227], Gu Guangyu [7357 1639 3768], et al. of the Institute of Basic Medical Sciences, Academy of Military Medical Science, Beijing]

[Text] A fragment of cDNA of hepatitis D virus genome, covering N-terminal 118 amino acids of HDAg, was cloned into expression vector pEx31. This insertion resulted in a MS2-polymerase-HDAg fused protein of 232 amino acids under the control of P Promoter. Cells harboring plasmid pEx-HDAg derived from the above construct overproduced a 27 kD fused protein in *E. coli* at a level of 30 percent of total cellular protein. Western blot analysis showed the MS2-HDAg fused protein could be recognised by the specific anti-HDAg IgM in HDV patient's serum. The significance of the expressed recombinant HDAg protein and its antigenicity was discussed.

Preparation of Photobiotin-Labeled DNA Probe of Coxiella Burnetii

40091015G Beijing ZHONGHUA WEISHENGWUXUE HE MIANYIXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 12 No 2, Apr 92 pp 120-122

[English abstract of article by Yang Chunmu [2799 2504 2606], Chen Xiangrui [7115 7449 5605], et al. of the Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, Beijing]

[Text] DNA from Coxiella burnetii strain Qiyi, phase I strain, was purified and digested completely with the restriction endonuclease PstI. The digested fragments were ligated with plasmid pAT153 and 200 recombinant colonies were obtained. The recombinant pCY31, containing 3.0 kb *Coxiella burnetii* DNA, was selected as the probe. After amplification and purification, the 2.9 kb fragment was labelled with photobiotin. The labelled fragment was hybridized with several rickettsiae DNAs respectively and coloured with the alkaline phosphatase system. The positive results can be found only with DNAs from four strains of Coxiella burnetii, strains Qiyi, Xinqiao, Ys-8, and Henzerling. The pCY31 did not hybridize with the DNAs from Rickettsia Prowazeki Madrid E Strain, spotted fever group rickettsiae Rickettsia sibirica strain 246 and chinese isolates 054 strain, Jinghe strain. This probe could detect 50 pg of *Coxiella burnetii* DNA. The results mentioned above suggest that the fragment could be used as an accurate probe with good sensitivity and specificity to identify the *Coxiella burnetii*. The fragment was cleaved into six smaller ones after digestion with HaeIII.

Study on Anti-Idiotypic Antibodies Against Monoclonal Antibodies to Anthrax Protective Antigen

40091015F Beijing ZHONGHUA WEISHENGWUXUE HE MIANYIXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 12 No 2, Apr 92 pp 112-115

[English abstract of article by Li Shenghua [2621 0524 5478], Zhan Yiqun [6124 6522 5028], et al. of the Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, Beijing]

[Text] The anti-idiotypic antibody (Ab_2) was prepared by immunization of a sheep with anti-PA (anti-Anthrax protective antigen) monoclonal antibodies (McAb-4G11, class IgM, Ab_1). The sheep anti-serum was purified by immuno-affinity chromatography. ELISA and the inhibition of BA-ELISA were used to identify the specificity of Ab_2. The results showed that the Ab_2 could react specifically with Ab_1 but not react with normal mice immunoglobulin, and inhibit PA to react with Ab_1. The $Al(OH)_3$ adsorbed Ab_2 was used to immunize BALB/c mice, out of 5 immunized mice, 4 mice showed anti-PA antibody and protection against challenge. The

result demonstrated the Ab_2 possessing an "internal image" of PA. It suggests that the Ab_2 might be used as a vaccine to induce anti-PA immune response.

Amplification of Dengue 2 Virus Sequences With Polymerase Chain Reaction After Reverse Transcription

40091015H Beijing ZHONGHUA WEISHENGWUXUE HE MIANYIXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 12 No 2, Apr 92 pp 123-126

[English abstract of article by Chen Huosheng [7115 3499 0524], Guo Huiyu [6753 6540 3768], et al. of the Department of Microbiology, Sun Yat-sen University of Medical Sciences, Guangzhou, and Chen Huanyong [7115 3562 0516] of the Logistic Department, Institute of Military Medical Sciences, Guangdong Command]

[Text] Two dengue 2 virus strains, prototype New Guinea C (NGC) and local isolate Hai-nan 98 (HN98), were purified from infected supernatants of Aedes Albopictus C6/36 cells. DV_2 RNA were extracted and characterized. DV_2 cDNA were synthesized through reverse transcription (RT) by using cDNA synthesis kit (Amersham). The first strand cDNA yield was about 12.3 percent. A pair of 20mer oligonucleotides was designed as primers (Primers CHS) based on the conservative sequence of DV_2 E gene. Primers VD was kindly provided by Dr. Deubel. DV_2 partial E gene had been amplified with the standard polymerase chain reaction (PCR). The PCR products were analysed by 3 percent Nusieve agarose gel electrophoresis, HinfI digestion, dot and Southern blotting hybridization. The results showed the amplified products were DV_2 partial E sequences. The target sequences of primers CHS and primers VD were DV_2 E 1-476nt and E 39-305nt, respectively. The specific amplification of DV_2 E sequences including local isolate by RT-PCR might be helpful in clinical diagnosis of DV_2 infections and genetic analysis of local isolates.

Establishment of Xenohybridoma Cell Lines Secreting Human Monoclonal Antibodies Against HBsAg

40091015E Beijing ZHONGHUA WEISHENGWUXUE HE MIANYIXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 12 No 2, Apr 92 pp 78-82

[English abstract of article by Zhang Yongzhong [1728 3057 1813], Zheng Jing [6774 5464], et al. of the Institute of Liver Diseases of PLA, Beijing]

[Text] When the spleen cells and the peripheral blood lymphocytes from anti-HBs positive donors were fused with mouse myeloma cells of SP2/0 line, xenohybridomas were obtained at a high frequency (1.9×10^{-5}). In 4 fusion experiments we acquired 13447 hybrid clones of mouse-human xenohybridomas. There were 48 anti-HBs positive wells in 3065 wells in which xenohybridomas grew. From the 48 wells 8 clones of xenohybridomas secreting human monoclonal antibodies against HBsAg were obtained. Of these xenohybridomas 6 clones were characterized. These xenohybridomas all contained both parent chromosomes, human chromosome distribution was from 5 to 12. Antibodies secreted early by these hybridomas were all complete molecule IgM, and after longer cultivation one strain (12B7) contained heavy chain only, and another one (19E8) secreted light chain only, but they yet retained anti-HBsAg specificity. Among the 6 xenohybridoma clones 4 were stable to secrete human monoclonal antibodies up to 6 months.

Additional Note on Jiangnan-II 010 Minisupercomputer

92P60329C Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 21, 27 May 92 pp 67, 69

[Article by Lu Shaofu [7120 4801 4395] of the Jiangnan Institute of Computing Technology: "The Upsurge of the Nineties: Super-High-Speed Computers Move Toward Parallel Processing"]

[Excerpts] [passage omitted]

For example, the Jiangnan-II [010] minisupercomputer, unveiled in 1991 [see JPRS-CST-91-024, 23 Dec 91 p 14], is a parallel processing system consisting of 11 486 processors. Its peak performance is 160 MIPS, its multiprocessor operating system is fully compatible with Unix System V, its parallel design language is fully compatible with the widely used C, FORTRAN, and Pascal, and it comes with a parallel debugging support tool. According to preliminary statistical comparison, the system's average actual speed is 110 MIPS, and its processor speed-up ratio is about 90 percent. This indicates that China has established a firm foundation for further development and application of parallel computers. [passage omitted]

Large-Vocabulary Connected-Chinese-Speech Recognition System Described

92P60314A Beijing JISUANJI XUEBAO [CHINESE JOURNAL OF COMPUTERS] in Chinese Vol 15 No 5, May 92 pp 364-370

[Article by Li Jianmin [2621 1696 3046], Zhao Tongqing [6392 1749 7230], et al. of the Speech Laboratory, Department of Computer Science and Technology, Qinghua University, Beijing 100084: "Approaches to Large-Vocabulary Speech Recognition Based on Chinese Speech Characteristics"; MS received 18 Sep 90]

[Abstract] Some approaches to Chinese speech recognition are discussed and a practical Large-Vocabulary Chinese Connected Speech Recognition System is introduced. In this system, characteristics of Chinese speech—such as the syllabic nature of the Chinese language, and the combination of initial consonant with final vowel—are taken into consideration. The user friendly interface makes it easily updatable for new words. With a vocabulary of over 10,000 words, the system demonstrated an average accuracy of 93.1 percent (top candidate) during a test conducted on 4 February 1991, and passed formal technical appraisal on 6 February 1991.

The system runs on a GW386 [Great Wall 386] microcomputer together with one TMS320C25 board (for speech sampling, LPC-CEP [linear predictive coding/coding of excitation parameters] calculations, syllable segmentation, SVQ [segmental vector quantization], and four-tones recognition) and two TMS32010 boards (for SVQ-SPM [SVQ-segmental probabilistic model] sample matching). Sampling rate is 9.6 kHz, the transfer function (z-transform) for high-frequency elevation is $1 - 0.97 z^{-1}$, the Hamming window for the window function is 25.6 ms, and the window shift is 12.8 ms. Schematics for the syllable-recognition subsystem and for the overall system are shown below in Figures 1 and 2.

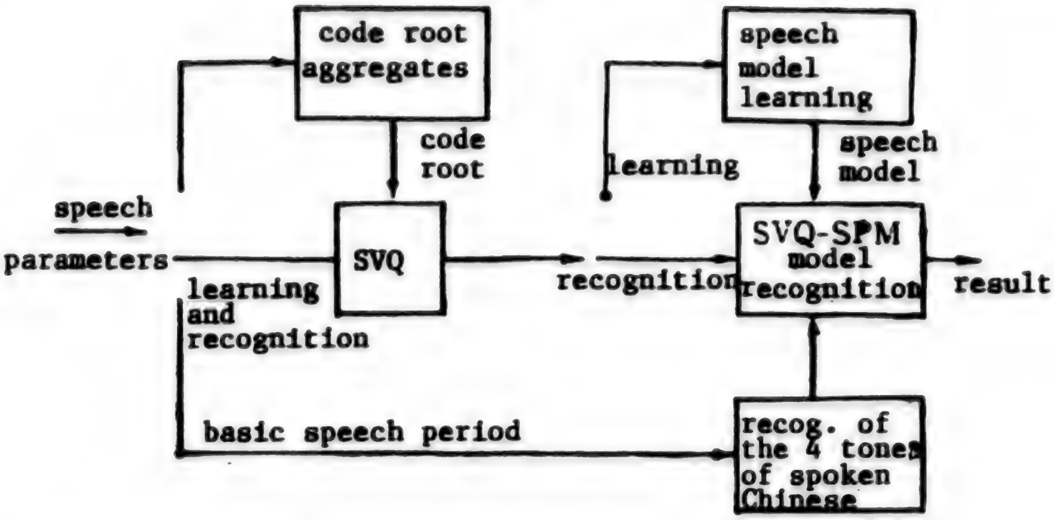

Figure 1. Schematic of Syllable-Recognition Subsystem

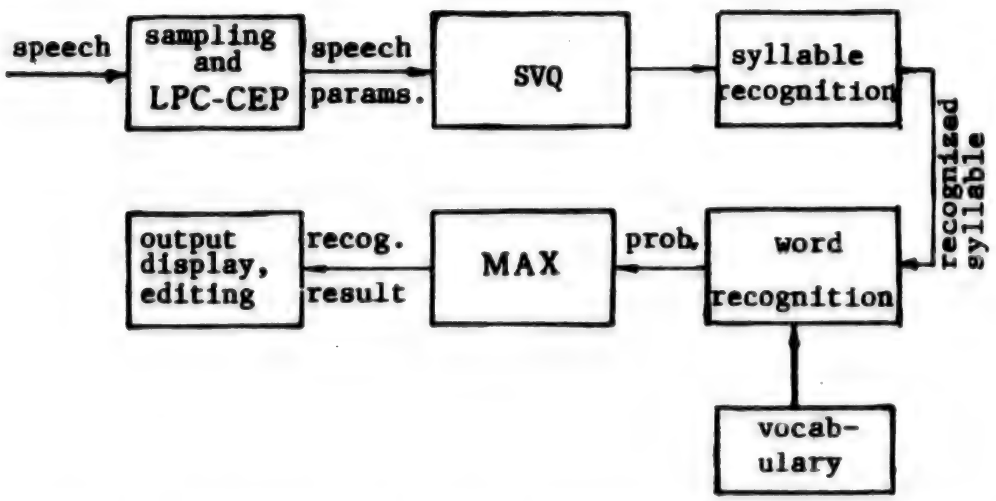

Figure 2. Schematic of Overall Speech Recognition System

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Discovery-Based-Logic Intelligent Software Development Project Described

92P60329B Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 21, 27 May 92 p 1

[Article by Chen Chunmei [7115 2504 2734]: "New Advances in Nation's Research on Machine Discovery Theory"]

[Summary] A project entitled "Discovery-Based-Logic Intelligent Software Development Technology," assigned by a State 863 Plan expert group, has passed the formal technical appraisal conducted by the Ministry of Aerospace Industry. The project, undertaken by a Beijing Aerospace University research team led by Prof. Sun Huaimin [1327 2037 3046], has assimilated foreign research on discovery-based logic theory and has achieved new domestic breakthroughs. Prof. Sun's group has built a partial two-stage logical deduction system for hypothesis calculating (testing); the system uses Boolean loops to permit use of Boolean equations for problem solving. The system's design and technical performance are at the international state-of-the-art. In addition, the group has used this advanced technology to develop three utility intelligent software packages (the PC-ALP logic program automatic design system, the SUN-ALP logic program automatic design system and the DES-FOOP fault logic diagnosis expert system development tool), as well as three scientific experiment software packages (the DL mathematics discovery system, a knowledge program design system guided by computer-aided intuition, and an intelligent database system). The experts have appraised these systems as being state-of-the-art.

OSI Computer MAN Software Certified

92P60329A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 20, 20 May 92 p 21

[Article by Li Hongfang [2621 1347 5364]: "Metropolitan-Area OSI Computer Network Software Passes Expert Appraisal"]

[Summary] The "Nanjing OSI [Open Systems Interconnection] Computer Metropolitan Area Network (MAN) and High-Layer-Protocol Software" for the "Nanjing Metropolitan-Area Computer Information & Services System's network construction" project passed expert appraisal a few days ago in Nanjing. This software, jointly developed in a 5-year effort by the Jiangsu Province Computing Institute, Nanjing University, Southeast University, and Nanjing Institute of Aeronautical Engineering, is supported by a closed operating system built for three types of mainframe and mid-sized computers—DPS8/49, M-240D, and IBM4341. The independently developed large OSI network software is compatible with the widely used X.25 packet switching network protocol. The software's overall performance meets late-eighties international standards.

Demonstration of Uniform Illumination on Target by Focusing High-Power Laser Beam

92FE0479A Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 12 No 3, Mar 92 pp 213-217

[Article by Liang Xiangchun [2733 0686 2504], Chen Zezun [7115 3419 1415], and Deng Ximing [6772 6932 6900] of Shanghai Institute of Optics and Fine Mechanics (SIOFM), the Chinese Academy of Sciences; MS received 24 Apr 91, revised 30 May 91]

[Text] **Abstract**

A focusing system consisting of a hexagonal array of spherical lenses and an aspherical principal focusing lens used to improve the illumination uniformity of the focused high-power laser beam (10^{12} W) on the surface of the target is demonstrated experimentally. The use of this system in laser-driven high-pressure shock wave experiments is reported. The data show that the flatness of the laser-driven shock wave is drastically improved with more uniform illumination.

I. Introduction

As we make further progress in experimental laser plasma physics, uniform illumination of target surface with a high-power laser becomes a more pressing requirement. To this end, the authors did some exploratory work and presented a focusing method involving the use of a lens array.[1-2] The element of the lens array described in reference 1 is a circular lens which is spherical on one side and flat on the other. When these circular lenses are glued together on an optical plate to form the array, approximately 6 percent of the laser power is lost due to the opaque glue between the lenses. After reference 2 was published, the method attracted considerable interest abroad. It is called the Chinese method; its unique feature is a uniform quasi-near-field large focal spot (diameter about 400 μm). The light intensity at the edge exponentially drops to zero. The method is especially suited for laser-driven high-pressure shock wave experiments. A number of foreign laboratories have introduced various ways to obtain a uniform focal spot, including the random phase-plate technique[3] developed at Osaka University, Japan; the transmissive or reflective stair mirror technique developed by the Naval Research Laboratory;[4,5] and the wide-bandwidth oscillator and multimode stepped-refractance optical fiber technique developed at Limeil Center in France.[6] Their common approach is to reduce or disrupt spatial coherence of the laser in order to obtain a uniform far-field focal spot. Although successful experimental results have been obtained, there is still a relatively weak light intensity distribution outside the main focal spot.

This paper reports the use of a focusing system comprised of an improved regular hexagonal lens array and a set of main focusing lenses to achieve uniform illumination on the target surface. Furthermore, the method has been verified in plasma physics experiments with a high-power Nd:glass laser.

II. Structure and Design Parameters of the Focusing System

In a laser target chamber, a regular hexagonal lens array is placed in front of an aspherical main focusing lens to form a focusing system. Figure 1 shows the regular hexagonal lens array. Due to the compactness of the structure, the gap between neighboring lenses is less than 20 μm. Hence, there is very little energy loss due to this array, approximately one part in 1,000. The parameters of the focusing system include those for the main focusing aspherical lens, i.e., aperture D of 200 mm and focal length F of 340 mm, and those of the regular hexagonal array of convex spherical lenses, i.e., aperture d of 30 mm (distance between two parallel sides of the hexagon), focal length f of 18,000 mm, concentricity $\theta \leq 10''$, and consistency of focus $(\Delta f/f) \leq 1.5 \times 10^{-2}$. The geometric diameter of the focal spot on the target is $\delta = (Fd/f) \approx 560$ μm.

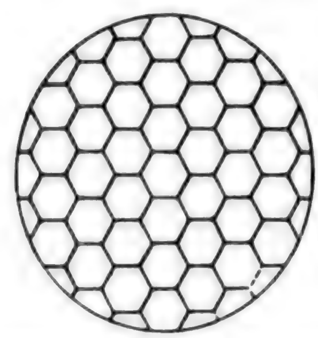

Figure 1. Arrangement of the Regular Hexagonal Lens Array

It is worthwhile to point out that if every lens element in the array has excellent concentricity ($\theta \leq 5''$), the Fresnel diffraction patterns of all those small lenses would overlap on the focal plane, causing large fluctuation of light intensity across the focal spot. Therefore, it is necessary to take this issue into consideration in the fabrication of those lenses. The concentricity requirement was reduced to $\theta \leq 10''$ and the outcome was much improved. The diffraction ring inside the focal spot was eliminated and light intensity fluctuation was reduced. It became more favorable for providing a uniform illumination across the target.

The principle regarding the ability of the focusing system to improve target illumination uniformity has been described in references 1 and 2 and will not be repeated. Some valuable experimental results are discussed as follows.

III. Experimental Results

1. Picture of Uniform Focal Spot

A single-mode CW YAG laser was used as the light source. After going through a 1:100 beam expander, the output is a 1.06-μm laser beam with a 200-mm aperture. Figure 2 [photograph not reproduced] shows the focal spot after it passes through the regular hexagonal lens array and the main focusing lens. Figure 2 was taken after enlarging the focal spot on the focal plane of the focusing system. Obviously, with the exception of some edge diffraction, the majority of the focal spot is uniform. The focal spot shown in Figure 2 was further examined with a silicon target camera tube two-dimensional image display and the two-dimensional light intensity distribution of the focal spot is shown in Figure 3. It reveals a light intensity plateau. The picture was further analyzed quantitatively with an FC digital image processing system to obtain an equal-density line distribution as shown in Figure 4. The diameter of the equal-density zone is approximately 400 μm.

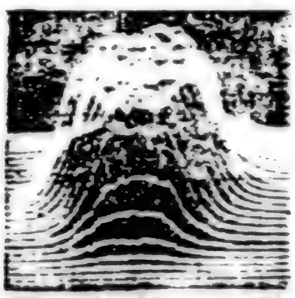

Figure 3. Two-Dimensional Intensity Distribution on the Focal Spot

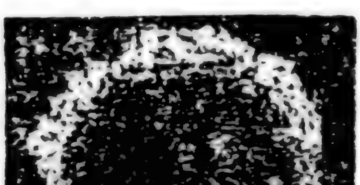

Figure 4. Equal-Density Line Distribution (flat top diameter: 400 μm)

In order to illustrate the uniformity effect of the focusing system, the one-dimensional intensity distribution of a beam of light with an extremely uneven near-field intensity distribution which passes through the main focusing lens, but not the lens array, is shown in Figure 5(a) [photograph not reproduced]. The light intensity modulation is as high as +/- 45 percent. After installing the regular hexagonal lens array into the focusing system, the intensity fluctuation across the focal spot is reduced considerably, as shown in Figure 5(b) [photograph not reproduced]. The intensity modulation is only +/- 10 percent. This illustrates that even when the incident light has a very poor near-field distribution, the focusing system with such a lens array can result in a smooth and uniform illumination across the focal spot.

2. Verification of Target Illumination Uniformity

The focusing system with a regular hexagonal lens array and a main focusing lens has been successfully used in the target chamber of the LF-12 laser, which has a power output of up to 10^{12} W. This allows us to proceed with research topics involving the interaction between matter and laser light of uniform illumination.

(a) Sensitivity of Focus Adjustment

Before using a high-power laser to hit a target, a low-power laser beam (power density on target surface is (1-2) x 10^1 W/cm^2) is usually used to evaluate the focus adjustment sensitivity of the system. A copper plate with a small hole is placed on and off the focal plane to measure the percentage of energy transmitted in order to determine the range of focus adjustment allowed. Since the focal spot is essentially symmetric in front and behind the focus, two sizes of small-aperture targets are used to complete the entire range of measurement. Table 1 shows a set of data taken. The data shows that the transmissivity of energy virtually does not vary within 150 μm of the focal plane. This indicates that the focus adjustment accuracy requirement of the system is far more lenient than that with using an aspherical lens alone. This makes focus adjustment far more convenient.

Table 1

Focal plane position	-300 μm	-150 μm	0	150 μm	300 μm
Transmissivity of energy φ = 530 μm			75%	73%	64%
Transmissivity of energy φ = 400 μm	31%	33%	35%		

(b) Variation of Laser-Induced Shock Wave Luminescence Signal

In laser-induced high-pressure shock wave experiments,[7] very good results were obtained with uniform target illumination. The interaction between laser and planar

aluminum foil targets was done using a 1.05-μm-wavelength laser with a pulse width of approximately 1.2 ns. The final-stage energy output was about 500 J and the on-target power density was (1-2) x 10^{14} W/cm^2. The luminescence signal from the back side of the target due to shock-wave heating was recorded with a streak camera. It was found that the luminescence signals due to the laser-induced shock wave were significantly different with and without the regular hexagonal lens array, as shown in Figure 6. The narrow vertical signal on the right is a time reference signal brought in via an optical fiber. When using the aspherical lens alone, in order to obtain the same focal spot, the target was placed off-focus and the result is shown in Figure 6(a). In this case, the leading edge of the luminescence signal bulges up in the middle and lags behind on the sides. This type of laser-induced shock wave cannot meet the experimental requirement for a high-pressure equation of state. When a regular hexagonal lens array and a principal focusing lens were used, the result is shown in Figure 6(b). This indicates that when there is target illumination uniformity, the shock-wave pressure is also consistent and an excellent planar laser-induced shock wave can be obtained. This is the most convincing evidence for target illumination uniformity. Once this is done, it will be possible to take measurements for laser-induced high-pressure equations of state to obtain a series of valuable results.

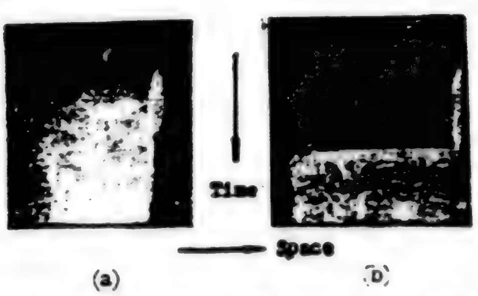

Figure 6. Luminescence Signal at the Back Surface of Aluminum Foil Obtained by the Streak Camera. (a) Only principal focusing lens; (b) Principal focusing lens with a regular hexagonal lens array

The authors wish to thank the entire LF-12 staff for their support and collaboration. They also wish to express their gratitude to the optics shop of SIOFM for their effort in making the hexagonal lenses with high precision.

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Optoisolator for 10.6-Micron Coherent Laser Radar With Common Transmitter/Receiver Antenna

92FE0479B Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 12 No 3, Mar 92 pp 265-268

[Article by Sun Dongsong [1327 2639 2646], Liu Zhaoyan [0491 0340 1484], Nan Jingda [0589 0079 6671], Qiao Lijie [0829 4539 2638], and Pi Mingjia [4122 0682 0857] of the Department of Applied Physics, Harbin Institute of Technology, Harbin 150006: "A 10.6-Micron Optoisolator With Common Transmitter/Receiver Antenna"; MS received 4 Mar 91, revised 3 Jun 91]

[Text] **Abstract**

The effect of an optoisolator in a coherent laser radar with a common transmitter/receiver antenna is discussed. The characteristics of 1/4λ phase retardation with internally reflective wave plate are analyzed. In addition, polycrystalline germanium 1/4λ Fresnel rhombs have been fabricated. The rhomb works well in a CO_2 laser heterodyne detection system with an energy conversion efficiency of more than 93 percent.

I. Introduction

Coherent infrared laser radar is a high-sensitivity laser radar developed in the past 20 years. It can share the same optics and scanner with an infrared imaging device and it is highly compatible with other devices. Hence, it receives a great deal of attention. A coherent laser radar usually shares a common transmitter/receiver antenna[1] and one of its key components is a polarized optoisolator.

The theoretical aspect of the 1/4λ wave plate and Fresnel rhomb used in the optoisolator is discussed. In addition, polycrystalline 1/4λ Fresnel rhombs have been developed and used in CO_2 laser heterodyne detection systems.

II. Quarter Wave Plate and Fresnel Rhomb

Figure 1 is a simplified sketch of the transmitter/receiver structure of a coherent CO_2 laser radar. The polarized optoisolator is composed of a Brewster beam splitter and 1/4λ Fresnel rhomb phase retarder (wave plate). Its function is to increase the power of the light emitted. Moreover, the isolated beam does not return to the laser oscillator. Nevertheless, wave-plate dispersion is a very serious problem; the wave plate can only be used at a specific wavelength. For example, CdS single-crystal 1/4λ wave plate is usually used in the infrared. At 10.591 μm, it is usually made into a 5/4λ wave plate[2] and is 1.018 mm in thickness. Based on the data of the refractive index of CdS as a function of wavelength,[3] the theoretical dispersion of a CdS 5/4λ wave plate in the vicinity of 10.591 μm is shown in Figure 2. The dispersion is quite serious. At certain wavelengths, the wave plate has retarded the phase by 1/2λ, instead of 1/4λ.

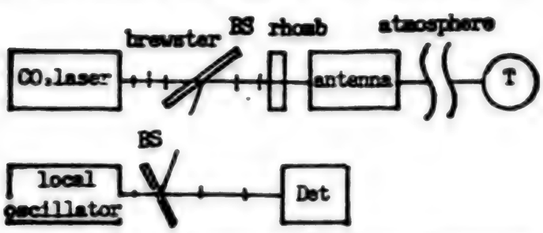

Figure 1. Basic Diagram of CO_2 Laser Heterodyne Receiving

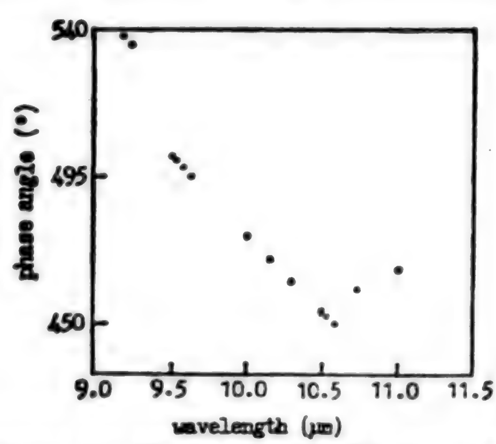

Figure 2. The Distribution of 5/4λ CdS Wave Plate Near 10.591 μm

Another way to achieve phase retardation is by total internal reflection. When a light beam enters a denser medium from a less dense medium at an angle greater than the critical incident angle, it is not only totally reflected but also causes a phase change in the two incident field components. According to theoretical electromagnetism,[4] the phase difference is

$$\delta = 2\tan^{-1}\frac{\cos\theta_i\sqrt{\sin^2\theta_i-(1/n^2)}}{\sin^2\theta_i}, \qquad (1)$$

where θ_i is the angle of incidence and n is the index of refraction. Unlike the dispersion caused by a wave plate, this kind of phase retarder can be used over a wider wavelength range. Figure 3 shows the calculated distribution of 1/4λ Fresnel rhomb phase retarders made of Ge and ZnSe based on equation (1) and the index of refraction versus wavelength data given in reference 3. The Ge phase retarder only varies by 0.25° in phase over the wavelength range of 2-20 μm. When $\lambda > 5$ μm, there is almost no change at all. Therefore, this kind of Fresnel rhomb phase retarder has very good chromatic characteristics in the infrared. In a CO_2 laser radar, this phase retarder enables the system to operate at all branches of the CO_2 laser. Consequently, the effect of changing CO_2 laser line on the laser radar can be minimized.

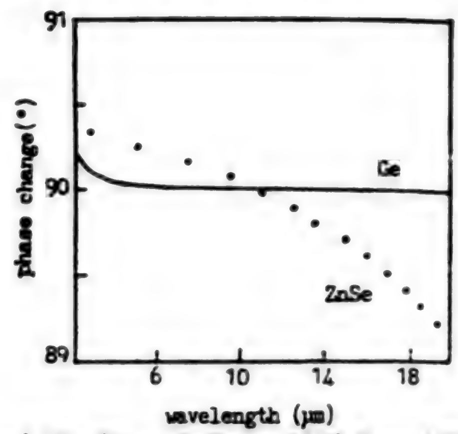

Figure 3. The Chromatic Curve of 1/4λ Fresnel Rhomb

III. Ge Quarter-Wave Fresnel Rhomb

Ge and ZnSe are materials often used in the infrared. Figure 4 shows calculated phase changes due to a single internal total reflection for Ge and ZnSe. In order to produce a phase change of π/2, it requires one internal total reflection for Ge and two for ZnSe. From the figure, one can see that there are two incident angles which result in a specific phase shift. In practice, the larger angle of incidence is always chosen because the slope of phase shift is higher near the smaller angle of incidence. The fabrication and functional requirements of the rhomb then become more critical. The internal incident angle of the rhomb which produces a phase shift of δ in a single total reflection is

$$\theta_i = \sin^{-1}\left(\frac{n^2+1\pm\{(n^2+1)^2-4n^2[1+\tan^2(\delta/2)]\}^{1/2}}{2n^2[1+\tan^2(\delta/2)]}\right)^{1/2} \qquad (2)$$

Therefore, the internal incident angles are $\theta_i = 42.93°$ and 65° for Ge and ZnSe 1/4λ rhomb, respectively. Usually, it is more appropriate to choose an internal incident angle close to 45° for the rhomb. In this case, the

beam travels the least distance inside the crystal and with the least loss as well. That is why Ge was chosen to be used in the making of a single-internal-reflection $\pi/2$ phase retarder. Figure 5 shows its structure. The internal incident angle is equal to the two base angles of the rhomb. The beam enters perpendicular to the rhomb. The polarization angle is 45° off the incident plane. The exit beam is circularly polarized and perpendicular to the exit plane.

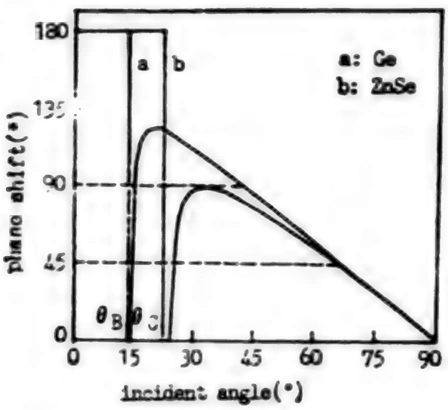

Fig. 4 The phase shift with each internal reflection

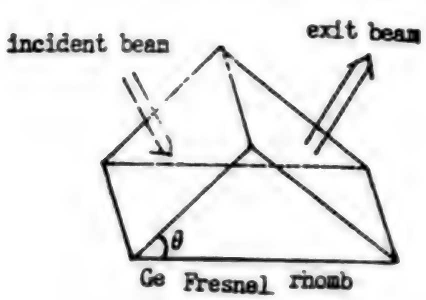

Fig. 5 1/4λ Ge Fresnel rhomb

IV. Experiment

The polarization characteristics of the Ge rhomb fabricated were measured using a Brewster plate detection technique. It was found that when the incident beam is linearly polarized, the phase shift is retarded by $\pi/2$ from the directions of the long and short axis of the exit beam and the ratio of light intensity along those two directions. When two 1/4λ Ge rhombs are staked together, the direction of polarization is rotated by 90°. In addition, when the incident and exit plane were uncoated, the energy conversion efficiency was only 40 percent. After putting on anti-reflective coatings, it is raised to over 93 percent.

The optoisolator shown in Figure 1 was also measured experimentally. A Ge beam splitter was used as the Brewster plate. The retarder is a 1/4λ Ge rhomb with anti-reflective coatings. The reflection targets included a gold mirror and an aluminum plate. It was found that the direction of polarization of the return beam was rotated by 90°. Moreover, the outcome remained the same for both targets. The overall conversion efficiency is approximately 70 percent, which is considerably higher than the 25 percent maximum efficiency without an optoisolator. The degree of isolation for the component parallel to the incident plane is 20 dB. The degree of isolation with respect to the perpendicular component is determined by the number of Brewster plates used. The larger the number is, the higher the degree of isolation becomes.

Conclusion

A polarized optoisolator consisting of a Ge 1/4λ Fresnel rhomb and Ge Brewster beam splitters have been successfully used in a CO_2 laser heterodyne detection system.

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Beam Propagation for Synthetic Aperture System Through Atmosphere

40100060A Chengdu DIANZI KEJI DAXUE XUEBAO [JOURNAL OF UNIVERSITY OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA] in Chinese Vol 21 No 1, Feb 92 pp 41-47

[English abstract of article by Hu Zhiping, Song Ruhua, and Yang Darang, Chengdu 610054, Institute of Applied Physics, UEST of China; MS received 2 Jul 91, revised 4 Sep 91]

[Text] Beam pointing, tracking and combining can be realized quickly by means of phase control of the synthetic aperture system. Based on the work of beam control in free space, it is shown that the synthetic aperture system can eliminate the influence of atmospheric turbulence on beam propagation. Numerical simulation is presented for the beam propagation in the atmosphere by means of fast Fourier transform (FFT) computational methods, and the results are demonstrated in three-dimensional figures.

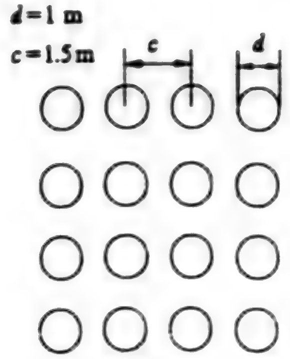

Figure 4. Schematic of Optical Synthetic Aperture System

The Design and Experiment of a Novel Optical Time-Division Multiplexing

40100060B Chengdu DIANZI KEJI DAXUE XUEBAO [JOURNAL OF UNIVERSITY OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA] in Chinese Vol 21 No 1, Feb 92 pp 48-52

[English abstract of article by Qiu Kun and Mei Kejun, Chengdu 6100054, National Key Lab. of Optical Fiber Communications, UEST of China; MS received 19 Jan 91, revised 20 Mar 91]

[Text] A novel optical time-division multiplexing (OTDM) system is proposed in which only a single picosecond (ps) semiconductor laser diode is used as the optical source and semiconductor laser amplifiers are used as high-speed modulators with built-in gain. The experimental results of 2 Gbit/s OTDM by two channels using semi-travelling-wave semiconductor laser amplifiers (STWA) as optical switches are given.

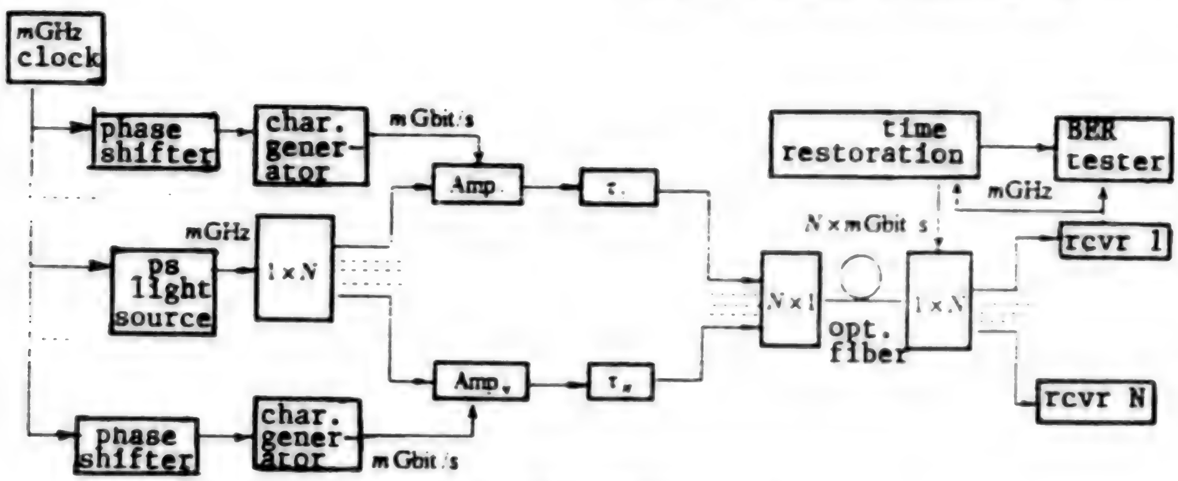

Figure 1. Schematic of OTDM Communications System

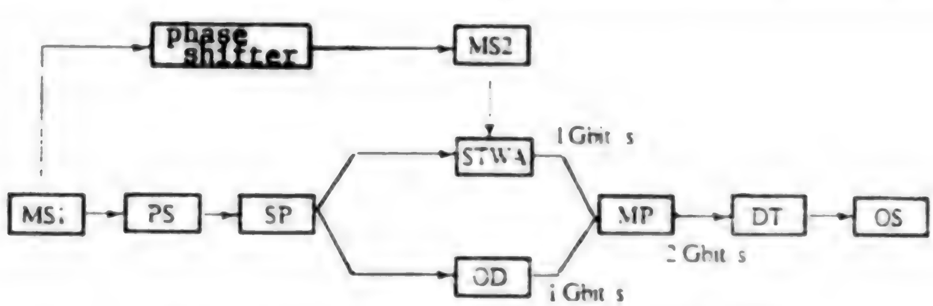

Figure 3. Schematic of OTDM Analog Experimental Apparatus

(MS = high-frequency signal generator, OD = optical delay line, MP = multiplexer, DT = detector, OS = sampling oscilloscope; PS and SP not identified)

Additional Details on Nation's First Laser Gate Array Laboratory

92P60328A Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 13 May 92 p 1

[Article by Zhang Jingan [1728 2417 1344]: "First Laser Gate Array Laboratory Operational"; cf. early brief report in JPRS-CST-92-012, 18 Jun 92 P 65]

[Summary] The nation's first laser gate array laboratory became formally operational on 4 May, indicating a major step forward for domestic development and production of digital ASICs. The laboratory's laser gate-array circuit development system is designed for 1.5-2.0 µm technology and ASICs of up to 5000 gates; single-gate delay is under 2 ns. Independently operated by laboratory technicians, the system has demonstrated a product yield of 25 percent, approaching the international standard. The entire fabrication process can be completed within 24 hours.

More on Domestically Developed VLSI Circuit for Character Processing

92P60328C Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 21, 27 May 92 p 52

[Advertisement: "A Boundless Universe Is Contained in a Square Inch"]

[Summary] The CSVGA (Chinese Super VGA) display card recently developed and marketed by the Beijing Legend Computer Group [see article and photograph in JPRS-CST-92-012, 18 Jun 92 p 56] is built around a 1-square-inch 21,000-gate VLSI chip that provides the basic processing and display functions of the card. The Chinese-character SVGA chip, designated TLX9200, uses 1 µm CMOS technology and comes in a 144-pin QFP [quad flat pack] package.

Sino-Dutch Joint Venture Shanghai Philips Semiconductor Co. Begins Business

92P60328B Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 21, 27 May 92 p 3

[News brief by Shi [1102]: "Sino-Dutch Joint Venture Shanghai Philips Semiconductor Co. Established"]

[Summary] The nation's largest-capacity, most advanced IC production facility has been created with the formal operation (beginning a few days ago) of the Sino-Dutch joint venture Shanghai Philips Semiconductor Co., based in the Caohejing Development zone. This joint venture between Shanghai Radio Plant No 7 and Philips has a 40,000-square-meter facility, a gross investment of US$52.2 million, and will use Philips' production and management technology to manufacture 70 million TDA ICs annually.

Short-Channel MOSFETs on ELO/SOI

40100058A Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 13 No 5, May 92 pp 270-273

[English abstract of article by Chen Nanxiang, Zhang Xuguang, Zhang Meiyun, Li Yingxue, and Wang Yangyuan of the Institute of Microelectronics, Beijing University, Beijing, 100871; MS received 20 Jan 91, revised 8 May 91]

[Text] Short-channel [1-µm-long] MOSFETs have been fabricated on ELO/SOI [epitaxial lateral overgrowth/silicon on insulator] structure. Electron and hole field-effect mobilities of the MOSFETs are 360 cm^2/V-s and 200 cm^2/V-s, respectively. The sub-threshold slopes are 190 mV/dec (P-channel MOS) and 220 mV/dec (N-channel MOS), respectively. The leakage current is less than 10^{-10} A/µm. The characteristics of MOSFET/SOI [devices] are discussed.

Wannier-Stark Effect of GaAs/GaAlAs Superlattices Under Electric Field

40100058B Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 13 No 5, May 92 pp 316-321

[English abstract of article by Zhang Yaohui, Jiang Desheng, and Li Feng of the National Laboratory for Semiconductor Superlattices and Microstructures, Institute of Semiconductors, Chinese Academy of Sciences, Beijing, 100083; Zhou Junming and Mei Xiaobing of the Institute of Physics, Chinese Academy of Sciences, Beijing, 100080; MS received 2 Dec 91, revised 7 Jan 92. This work was supported by the National Natural Science Foundation of China (NSFC).]

[Text] The Wannier-Stark effect of GaAs/GaAlAs superlattices under electric field by photocurrent measurements at room and low temperatures is investigated. At intermediate electric field, we have observed the spectral shapes of photocurrent corresponding to the evenly spaced "Stark Ladder." We have found that the transitions of exciton state from quasi-3D to quasi-2D regime are due to Wannier localization. The change of intensity of the exciton transitions with electric field is well consistent with theoretical calculations based on the model proposed by Xia and Huang. Our results show that the structures in the photocurrent spectra at room temperature and at relatively low field (1.0 x 10^4 V/cm) are caused by Wannier localization instead of saddle-point excitons.

Character of Lowest Conduction States of Ultra-Short-Period GaAs/AlAs Superlattices Investigated by Photoluminescence Under Pressure

40100058C Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 13 No 5, May 92 pp 322-326

[English abstract of article by Li Guohua, Liu Zhenxian, Han Hexiang, Wang Zhaoping, and Jiang Desheng of the

National Laboratory for Superlattices and Microstructures, Institute of Semiconductors, CAS, Beijing, 100083, and Klaus Ploog of the Max-Planck Institute fur Festkorperforschung, Germany; MS received 17 Dec 91]

[Text] The photoluminescence of ultra-short-period GaAs/AlAs superlattices has been investigated at 77K under hydrostatic pressure up to 30 kbar. The measured pressure coefficient of the emission peak for $(GaAs)_1/(AlAs)_1$ is -1.35 meV/kbar. This demonstrates that the lowest conduction state has the character of X valley of the bulk material rather than L valley predicted by theoretical calculations. The measured pressure coefficient for $(GaAs)_2/(AlAs)_1$ is 8.69 meV/kbar, which indicates that $(GaAs)_2$ $(AlAs)_1$ is the thinnest type-1 superlattice in the GaAs/AlAs system.

DPCM Digital Code-Compression System Developed for Broadcast Color TV

92P60327A Chengdu DIANZI KEJI DAXUE XUEBAO [JOURNAL OF UNIVERSITY OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA] in Chinese Vol 21 No 1, Feb 92 p 35

[Article by Li Lemin [2621 2867 3046], Guo Chengqing [6753 2052 3237], et al. of the University of Electronic Science and Technology of China (UEST): "Broadcast Color TV Transmission DPCM Code-Compression System"]

[Summary] UEST has developed a DPCM [differential pulse code modulation] digital code-compression system for broadcast color TV signal transmission. The color TV digital signal is compressed from 140 Mbps down to 68 Mbps, permitting two-way color TV transmission over one DS4 [i.e., 140 Mbps] channel or one-way color TV transmission over two DS3 [i.e., 34 Mbps] channels. The system includes two types of codec [i.e., coder/decoder] equipment—one for synchronous and one for asynchronous transmission—and has applications in long-range broadcasting of TV programs, national defense TV transmission, broadband integrated services digital networks (B-ISDN), and closed-circuit TV transmission.

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